PATENT SPECIFICATION (11) 1593738

(21) Application No. 46293/77 (22) Filed 7 Nov. 1977 (19)
(31) Convention Application Nos. 7633377 (32) Filed 5 Nov. 1977
7633378 5 Nov. 1977
7712879 27 April 1977
7733320 4 Nov. 1977 in
(33) France (FR)
(44) Complete Specification published 22 July 1981
(51) INT. CL.³ B65G 47/00 47/82
(52) Index at acceptance
B8A CF N21 N22 T1

1593738

(54) CONVEYOR SYSTEM FOR USE IN ASSEMBLING AND/OR MACHINING WORKPIECES

(71) We, MAURICE PRODEL, of Route de Vic-sur-Aisne, Carlepont, 60170 Ribecourt, France, and JACQUES PRODEL of 32, rue Saint-Eloi, 60400 Noyon, France, both of French nationality, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to multi-station machines for assembling and/or machining workpieces.

Machines are known comprising several working stations, each of which includes an apparatus for assembling and/or machining workpieces, and means for conveying the workpieces to be machined and/or assembled in front of each station in succession, the workpieces which have been assembled and/or machined in one station being then conveyed to the next station etc. In some of these machines, certain stations comprise automatically operating apparatus.

Many problems have to be solved in order to ensure satisfactory operation of these machines, or transfer machines, these problems deriving in particular from the fact that the workpieces not only have to be moved from one station to another, but must also be positioned extremely accurately at each station, at least when these comprise an automatic apparatus.

Moreover, when the station comprises a machining apparatus, the workpiece must be supported in order to resist the machining force.

Furthermore, the working times associated with the stations may be different one from the other because of the diversity of operations to be performed therein, and because the same operation does not always require exactly the same execution time.

In numerous transfer machines, each workpiece to be machined and/or assembled is carried by a workpiece support or pallet, and the workpieces are conveyed in succession in front of the various stations by fixing the pallets to a drive means which curculates in front of the various stations. Said drive means, as for example a chain, stops to enable the machining or assembly to be carried out by the apparatus in the various stations. However, in these machines, it is the apparatus requiring the longest operating time which controls the general working rate, such that the overall efficiency of the machine is relatively low.

To overcome this restriction, a belt may be used as the drive means, so that the pallets may be temporarily withdrawn from the belt to allow the machining or assembly of the workpieces which they carry, and then be returned to the belt for conveying to an adjacent station. However, the degree of automation is reduced thereby, the conveying of the workpieces suffers in accuracy and the behaviour during machining or assembly is sometimes unsatisfactory.

A machine has also been proposed in which a pallet fitted to a continuously driven chain or the like remains in front of a working position for a sufficient time because of the relative movements of those parts of the chain or the like adjacent to said pallet. However, in such a machine, in addition to the complication of mechanically providing the relative movement, it is necessary to provide very long chain arms or the like, and thus a considerable number of pallets, the number of workpieces actually worked being very low in relation to the number of workpieces waiting on the pallets fixed to the arms, so that the machine price is exceptionally high and its overall size large.

According to the present invention, there is provided a transfer machine for assembling and/or machining workpieces, comprising several working stations distributed

along a closed pallet circulation circuit equipped with a rail, and comprising also an endless drive means, passing in front each of the working stations, to which drive means are connected, by releasable coupling means, a plurality of workpiece support pallets disposed on the guiding rail, whereby the pallets may be indivdually, at predetermined points of the circulation circuit, uncoupled fron the drive means and pulled out of the circulation circuit, characterized in that the individual working stations are off-set from the circulation circuit and are equiped with pallet holding means also off-set from the circuit, in each of which holding means a pallet may be introduced individually by a displacement means, after uncoupling from the drive means, for proper positioning in view of the assembling and/or the machining of the workpiece it carries, and from which the pallet may be returned to the same point of the circulation circuit where the driving cooperation of the pallet with the drive means is re-established, and means are provided to allow the circulation of the other pallets on the circuit past the working station during the working operation performed in said station.

Preferably, an enclosure encloses the circulation circuit.

Preferably the pallets are driven positively by the endless drive means but may however be halted if required, while remaining connected to the chain.

It therefore becomes possible to circulate pallets along the circuit of the transfer machine while other pallets are halted while remaining connected to the drive means.

The machine preferably comprises, associated with a respective working station, a pallet stop means which operates until the workpiece carried by the previous pallet has been completely processed in its station, and the law governing the working of each of the stations thus becomes independent of the law governing the circulation of the pallet drive means.

The pallet halted in this manner becomes a stop for the subsequent pallets. In this respect, the drive means may provide for sinusoidal velocity curve of the circulation means, so that successive pallets come into contact at zero speed, and thus without there being any risk of changing the position of a workpiece on a pallet.

Not only does a working station become completely disengaged by being freed from the restrictions attached to the circulation means, but in addition the zones of operation of the personnel assiciated with the machine may be complaetely isolated from the zones in which the circulating pieces lie, so giving increased safety and better accessibility to the pallets carrying the workpieces to be machined and/or assembled.

In its general arrangement, the machine, in one of its embodiments, comprises two parallel faces for fixing the apparatus in adjustable positions in the working stations, this fixing mobility enabling machines of the same overall structure to be used for different assembly and/or machining operations.

A machine according to the invention may comprise some totally automatic stations and others for manual working. It comprises apparatus which may be easily adapted to any of the general working conditions.

By using a link chain and a friction mounted pinion for driving the pallets, it becomes particularly easy to couple and decouple them during their transverse movement.

The invention provides one embodiment in which the pallet movement circuit comprises two parallel straight arms connected by circular arcs, means being provided to retain the pallets against the effects of the centrifugal force when they circulate around said arcs.

It also provides an embodiment in which the pallet movement circuit is circular.

The machine may include a device for monitoring the operation of automatic machining and/or assembling apparatus.

In said automatic apparatus for machining workpieces or assembling them, the plurality of members which comprise the apparatus move along predetermined strokes during its operation, and in addition some of said members may assume one or another of several states.

At the present time, it is difficult to monitor the operation of such apparatus, and in particular to locate a fault when it occurs. In this latter case, it is necessary in most cases to completely cheek the apparatus, in particular its electrical circuits, and this requires the help of at least one specialist.

The present monitoring device overcomes this difficulty, in that the positions of the various operating members of the automatic apparatus, and possibly their state, are indicated at any moment on a mimic diagram associated with the apparatus to be monitored, said mimic diagram indicating the positions and states to be attained in the various stages for normal operation of the apparatus, so that the supervisor may both check correct operation and, in the case of a fault, identify it by means of the eye alone.

In one embodiment, in which the movemens of the members are divided into elementary strokes, the positions of a member are determined by sensors disposed at the ends of the elementary strokes. Each sensor is then associated with a light emitting diode or the like, which either lights or remains unlit according to whether the member has reached or has not reached said

end of the stroke.

Likewise, the device may comprise light emitting diodes or the like, which either light or remain unlit according to whether a member has assumed one or other of two conditions.

In one embodiment of the device, applicable when the operation of an apparatus may be defined by the fact that each member comprising it has either reached or has not reached one or the other of its ends of stroke, and one or several members have assumed one or other of two states, the device comprises light emitting diodes each of which corresponds to one end of stroke or to one state, and the diodes form part of a mimic diagram in the form of rows and columns on which markings are made which correspond to the normal operation of the device, it then being possible at any moment to compare the activated light emitting diodes with said markings, and so obtain monitoring.

Such a device for monitoring the operation of an automatic assembly and/or machining apparatus comprising one or more members which move along predetermined strokes and/or are able to assume different states, may comprise a double entry mimic diagram in the form of rows and columns, with indicating lamps opposite the various columns (for example) each of which lights to correspond to one operating stage of the apparatus, and indicating lamps opposite the horizontal rows (for example) which light when the corresponding member reaches one end of its stroke or assumes a predetermined state, so that it is possible to check for each operating stage whether the members have assumed the position and/or state corresponding to said stage, by merely ascertaining whether the corresponding indicating lamp or lamps have lit.

In one embodiment of said device, the rows and columns form a mimic diagram in the form of divisions, the divisions of a column corresponding to one stage being either transparent or opaque according to whether the indicating lamps for the horizontal rows on which they are placed light or do not light during said stage.

The double entry mimic diagram may be on a transparent panel which forms or is a part of the vertical wall of a box surrounding the apparatus, and slidably mounted in said box.

The transparent panel enables the members internal to the box to be directly observed.

The slidable mounting allows access to the box interior.

The panel advantageously forms the front wall of the box.

A cover may be disposed between two successive boxes of an installation comprising a plurality of apparatus, and is pivot mounted to be able to assume a position in which the track provided for the movenent of the pieces to be assembled and/or machined by the installtion is protected by said cover, and a position in which said track is accessible.

The description given hereinafter by way of example refers to the accompanying drawings, in which:

Figure 1 is a diagrammatic plan view of a transfer machine according to the invention;

Figure 2 is a diagrammatic perspectivc view of part of the machine, certain members being omitted;

Figure 3 is a cross-section through part of the machine;

Figure 4 is a cross-section through the machine;

Figure 5 is an elevation corresponding to Figure 1;

Figure 6 is a plan view corresponding to Figure 3;

Figure 7 is a partly sectional plan view of part of the machine;

Figure 8 is a vertical section through part of the machine;

Figure 9 is a vertical section through another part of the machine to an enlarged scale;

Figure 10 is a diagram;

Figure 11 is an elevation of another embodiment of the machine;

Figure 12 is a corresponding plan view;

Figure 13 is a vertical section through said embodiment;

Figure 14 is a corresponding partial plan view;

Figure 15 is a cross-section analogous to Figure 13, but in another state;

Figure 16 is a cross-section on a plane different than the sectional plane of Figures 13 and 15;

Figures 17a, 17b and 17c are diagrammatic plan wiews;

Figure 18 is a partial elevation of an automatic station;

Figure 19 is a perspective view of a machine according to the invention;

Figure 19a is a front view of a station in another embodiment;

Figure 20 is a partly sectional elevation of another embodiment of the machine according to the invention;

Figure 20a is a section on the line 20*a*—20*a* of Figure 19a;

Figure 21 is a corresponding plan view;

Figure 21a is a section on the line 21*a*—21*a* of Figure 19a;

Figure 22 is a very diagrammatic view of a gripping and transfer device;

Figure 23 is a diagram defining the strokes of the members and showing the sensors;

Figure 24 is a front view of an indicating mimic diagram;

Figure 25 is a perspective view of an apparatus provided with a monitoring device:

Figure 26 is a partially cut-away side elevation of a further monitoring device:

Figure 27 is a view of Figure 26 partly in plan and partly in section on the line 27-27:

Figure 28 is a side elevation for a different state:

Figure 29 is a front elevation, part of which shows a panel in the lowered position and part of which shows a panel in the raised position.

Figure 30 is a vertical sectional view of a pallet, in another embodiment:

Figure 31 shows a pinion in mesh with a chain:

Figure 32 is a perspective view of part of a machine in another embodiment:

Figure 33 is a plan view, partly in section, of part of such a machine:

Figure 34 is a transverse section of a station in another embodiment:

Figure 35 is a view similar to Figure 34 but for a different operating condition: and

Figure 36 is a view similar to Figures 34 and 35 but for a further operating condition.

The transfer machine comprises a certain number of working stations, namely six in the example shown in Figure 1, indicated respectively by 21, 22, 23, 24, 25 and 26. Stations 21, 22 and 23 are disposed along a first straight arm 27 of a link drive chain 28, and stations 24, 25 and 26 are disposed along an arm 29 parallel to the arm 27, the arms 27 and 29 being connected by part-circular parts passing over two end pulleys or wheels 31 and 32, so that the chain 28 forms a closed circuit.

The working stations are on opposite sides of a vertical plane 33 passing through the axes 34 and 35 of the pulleys 31 and 32.

The machine frame is constituted by two parallel beams 36 and 37 (Figure 2) symmetrical with each other about the plane 33, and of like construction. Said beams rest on legs 38 which terminate in a base 39.

A beam, for example the beam 36, comprises a web 41 (Figure 3) and flanges 42 and 43 which terminate in rims 44 and 45 in the case of the flange 42, and 46 and 47 in the case of the flange 43. The purpose of the rims 44 and 46 is to engage in a vertical plate 48, which slides longitudinally to allow initial adjustment of the position of a station along the frame. Fixing is carried out using clamping plates 49, 51, which are clamped by screws such as 52 and 53.

The station shown in Figure 4 comprises a head 55 in the form of a gripping clamp for a workpiece, carried by a vertically mobile device 56 comprising pistons 57 and 58 connected by a rod 59 and housed in cylinders 61 and 62, two columns 63 being provided to guide the upward and downward movement of the mobile device 56. The assembly is enclosed in a box 64 (Figure 2) which also encloses the means for driving and controlling the movement of the mobile device and the members comprising it. A starting button 66 and indicating lamp 67 project from the box 64, which extends on both sides of the plate 48. The box 64 also comprises manual control buttons 68. It further comprises an upper compartment 65 for housing electrical circuits.

Transparent screens, 69, 71, 72, 73 (Figure 5) on one machine face, and 74, 75, 76, 77 (Figure 1) on the other machine face, are disposed at the various stations on the connection between the boxes 64, and are held in the grooves 78 in the plates 48.

The stations 22, 23 and 26 comprise containers 81, 82, 83 respectively for feeding workpieces to be machined and/or assembled, and Figure 1 shows the feed channels 84 and 85 emerging from the containers 81 and 82 respectively. Boxes 87 and 88 are provided for controlling the feed containers 81 and 82.

The station 25 is designed for operation by a person and comprises a working table 86.

Uprights 101 and 102 (Figure 2) on one side and the other of the window 99 form and extension to the body 103 of the plate 48, and an entrance 105 comprising two lateral edges 106 and 107 connected by a front cross member 108 is fixed on to said uprights by screws 104 (Figure 6).

The inner opposing faces 109 and 111 of the edges 106 and 107 comprise grooves 112 and 113 respectively. The cross member 108 also comprises a groove 114.

Small beams 121 and 122 (Figure 4) run above and parallel to the beams 36 and 37 and slightly displaced towards the middle longitudinal plane, each small beam, for example the small beam 122, being fixed to the adjacent beam by uprights 123 with clamping plates 124 and 125 which cooperate with a rim such as 126 of the beam 37, so as to fix the beam in the required position.

Each small beam, as for example the small beam 122, comprises channels on its various faces, a channel 128 being used for fixing it on to the upright 123, and a channel 129 being used for fixing a sheath 131 housing bundles of conduits or wires, the sheath 131 being fixed by its other face to the other small bean 121. The upper groove 132 of the small beam 122 is used for fixing at any convenient point a finger such as the finger 133 which carries at its end a sensor 134 from which a wire 135 emerges to enter the corresponding control box 64 for an automatic apparatus. Staight rails 144 and 145 are mounted on the inner upper rims 45 of the beams 36 and 37 respectively, and face the arms 27 and 29 respectively of the chain 28 (Figure 6).

One rail, as for example 145, comprises a

gap opposite each barrier bordered by faces 146 and 147 (Figure 7). A rail portion 148 is provided in order to overcome the gap, its end faces 149 and 151 being initially opposite the faces 146 and 147. The rail portion 148 is fixed to the end of a rod 161 (Figures 7 and 8) rigid with the piston 162 of a jack 156 comprising bosses 157 and 158 traversed by the rods 154 and 155 which are likewise fixed to the portion 148. A second rail portion 150 is slidably mounted via its two bores 152 and 153 on said rods, and springs 162 and 163 are mounted on the rods 154 and 155 to rest on the faces 164 and 165 of the bosses of the jack body. The ends of the second rail portion 150 are rigid with blocks or projections 166 and 167 adapted to cooperate with the ends 168 and 169 of the fixed rail 145 adjacent to the stop faces 146 and 147.

The purpose of the rails 144 and 145 is to guide a plurality of pallets 181 (Figure 8). Each pallet comprises a pallet body 182, for example of plastics, with a vertical cross-section in the form of a U, comprising two branches 183 and 184 adapted to cooperate via their inner faces 171 and 172 with the vertical faces 186 and 187 of the rails 144 and 145 to guide the sliding of the pallets 181.

A pallet plate 188 (Figure 6) is rigid with the body 182 of a pallet 181. This plate is of generally rectangular profile with two transverse edges 189 and 191 and a longitudinal edge 192, these edges being connected by cut corners 193 and 194. The purpose of the pallets is to receive on the upper face 190 (Fig. 3) of their plate 188 the workpieces to be assembled or machined.

Each pallet comprises on its upper face two compartments 195 and 196 (Figure 8) each for receiving a magnetic block, the purpose of said block being to cooperate with the sensors 197 (Figue 6) distributed over the length of the rails 144 and 145.

Chain guides 203 and 204 are fixed on the outer faces 201 and 202 (Figure 4) of the small beams 121 and 122 respectively. The rods 205 (Figure 9) of the chain links are adapted to cooperate with the teeth of a pinion 206 fitted on each of the pallets 181. A pinion 206 mounted in a gap between the pallet body 182 and the plate 188. Its lower face is subjected to the action of a pusher 207 housed in a cavity 208 in the pallet body 182. and pushed by a spring 209 housed in said cavity.

A wheel or pulley device, such as the device 32, comprises a pulley body 211 (Figure 3) with an upper face 212 and a lower face 213 comprising a flange 214. Screws 215 fix the faces 212 and 213 together and to the rim 216 (Figure 9) of a pinion 217 comprising toothing 218 and 219 engaging with the rods 205 of the link chain 28, the plates 221 and 222 of which embrace the toothed rings 218 and 219.

The pulley device also comprises a fixed casing 223 (Figure 3) in which is rotatably mounted the shaft 224, rigid with the rotatable pulley via a sleeve 225. The skirt 226 of the casing 223 is adapted to cooperate by way of its inner surface 227 with the lateral cylindrical face 228, of the same radius (Figure 6), of the body 182 of the pallets 181.

Its operation is as follows.

The chain 28 is driven by the toothing 218 and 219 of one of the wheels 31 and 32 with a movement of which the speed obeys the relationship shown by the diagram of Figure 10. This is a sinusoidal diagram. Starting from zero time, the speed firstly increases very slowly, the acceleration being very small, then it increases very rapidly until it assumes a maximum value. It then decreases, and after a very rapid fall it is succeeded by a very small deceleration until it becomes zero.

When the non-rotating pinion 206 of a pallet 181 engages with the chain 28 driven in this manner, this pinion acting as a rack, the pallet moves forward with a velocity which changes according to a sinusoidal curve, the distance separating two points at which the speed is zero being precisely equal to the length of the plate 188, i.e. the distance separating its two transverse edges 189 and 191.

The pallet support 182 is located on all its lateral faces over those parts of the path in which it follows a circular arc.

When a pallet 181 arrives opposite an entrance 105, it is either introduced into the entrance or not, depending upon whether the magnetic block which it carries is disposed in the container 195 or container 196, only one of which comes opposite the sensor 197 corresponding to said entrance. If it is disposed for example in the container 195, said block cooperates with the sensor 197. The hydraulic jack 156 is then operated. By means of the rod 161, that portion of the rail 148 which carries the pallet 181 is displaced in a transverse movement. The pallet 181 engages in the grooves 112 and 111 of the entrance 105 by means of the transverse edges 189 and 191 of its plate 188. Its movement continues until its longitudinal edge 192 engages in the groove 114 and hits against the base of said groove. The pallet is then positioned correctly relative to the automatic, semi-automatic or non-automatic apparatus to which the entrance corresponds.

The operating member of the apparatus, namely the clamp head 55 in the case of the automatic apparatus shown in Figure 4, then carries out its assembly or machining action as required for the workpiece carried by the pallet plate 188. If a force is exerted on the plate, for example due to machining, it is resisted by the entrance 105.

At the end of stroke of the jack 156, the gap created in the rail 144 or 145 by pressing

out the rail portion 148 is made up by the second rail portion 150, which is set into its correct position by the flanges 166 and 167 abutting against the ends 168 and 169 of the fixed parts of the rail 144 or 145.

When the second rail portion 150 enters the fixed part of the rail 144 or 145, the rail continuity is re-established, so that further pallets may continue to circulate on the rail, which no longer contains the pallet displaced transversely. Their movement continues stepwise, for example until they come opposite the next entrance.

Where a particularly long operation has to be executed, the invention provides a station comprising two or more automatic apparatus executing the same operation, these apparatus being supplied by pallets at suitable times, the supply to the machine stations downstream being also properly ensured.

The machine is thus able to effect operations of different duration by its various automatic apparatus, while allowing each of them to work practically without interruption, so attaining optimum efficiency for the machine.

The machine also takes account of irregularities which may arise in the assembly or machining times for a workpiece, for example to take account of differences in the time required for obtaining a workpiece from a supply container.

The invention provides certain stations with a rail portion fitted to the jack rod such as that indicated by 150, but which is formed in such a manner as to form a stop for the pallet which follows that being introduced into the entrance.

If during operation a pallet driven by the chain 28 abuts against a halted pallet, the contact occurs at zero speed, and thus without the workpiece or pieces carried by the pallets becoming shifted.

The pulley device 32 resists the effect of centrifugal force because of the cooperation between the body 182 of the pallet 181 and the fixed skirt 223, so that no matter how high the circulation speed is, the workpieces do not become moved relative to the plate which carries them.

Where it follows a circular arc, the pallet support 182 is located on all its lateral faces.

Figure 4 shows a receptacle 231 situated opposite the channel 84 of the supply container 81, this receptacle being situated below the entrance 105 of said station, such that its stop edge 232 suitably positions the workpiece under the head 55.

Said head traverses the entrance through the gap between the two transverse edges 106 and 107 of the entrance before the pallet 181 has been introduced, grips the workpiece on the receptacle 231 and keeps it gripped in a raised position ready for disposing on the pallet or on a workpiece carried by the pallet, when this latter reaches its operating state.

The transparent walls 69, 71, 72, 74, 75, 76 and 77 help to ensure personal safety by isolating the person from the circulating pieces while enabling him to observe the pieces at rest.

The embodiment shown in Figures 11 to 19 is analogous overall to the embodiment described with reference to Figures 1 to 10. In this second embodiment, the machine, of rectangular configuration, comprises two longitudinal beams 381 and 382 (Figure 13) supported by three feet 301, 302, 303 (Figure 19) rising from bases 304, 305, 306 resting on the ground via pads 307 of adjustable height, these beams being of circular cross-section and constituting the framework for the machine on which a parallelepiped enclosure 309 is mounted, bounded by transparent walls of which the elements 311—315 (Figure 12) are held in grooves 316 comprising plates 317 (Figure 13) forming part of the machine structure. The machine also comprises a box or casing 308.

Cross members 421 are fixed on the beams 381 and 382 opposite each station, and comprise semi-circular bearing surfaces 422 and 423 which embrace the beams 381 and 382, fixing being effected by half collars 424 and 425 clamped by screws 426. The cross member 421 comprises branches 429 and 430 to the ends 427 and 428 of which are fixed the plates 317 (Figure 14) by screws.

In the embodiment shown in Figures 11 and 12, the machine comprises two automatic stations 321 and 322 along its major sides, the apparatus being fixed respectively on the verical walls or plates 317, these stations beng supplied with workpieces from containers 325 and 326 connected to said apparatus by channels 327 and 328 respectively.

The other side of the machine comprises a manually supplied station 331, with the operator having available a table 332 embracing an entrance 333. This side also comprises an automatic station 334, to which a supply container 335 is connected. A final station 336, situated on the first side, feeds the evacuation channel 337 for the finished pieces.

Upstream of the station 323, the pallets 338, driven by the chain arm 339, are shown spaced apart by twice their length. On the opposite chain arm 341, immediately upstream of the station 331, the pallets 338 are touching each other, for example because the operator has temporarily interrupted his work. Figure 12 thus shows seven touching pallets 338, then a further pallet distant from the last one in this row by the length of one pallet, then a further pallet distant by twice the length of one pallet etc.

At each of these stations, a pallet 338 is displaced transversely for introduction into

an entrance 333 or 342 (Figure 13) for the assembly or machining of the workpiece which it carries.

The rail portion 401 (left side of Figure 13 and Figure 14) carrying the pallet 338 is displaced from right to left by the jack 402 controlled via the sensor 403 when the pallet comprises a magnetic block. The rail portion 404 urged by the spring 405 takes the place of the portion 401, its movement being limited by the stops 406 and 407. The portion 404 may be a portion which extends the circulation rail and thus enable the pallets following that which has been introduced into the entrance to move past the station. Alternatively, it may be a rail portion comprising a stop which halts the next pallet plus the other pallets which follow it.

The pallet carrying the workpiece which has been assembled or machined is returned to the circulation circuit by a reverse movement of the jack 402. However, when the portion 401 has been returned to the circulation rail, the pallet does not reassume its movement on the rail until after the release of a latch which holds it on the rail portion for the time necessary for the chain drive speed to reach zero.

The left hand half of Figure 13 shows the state of an automatic apparatus, for example the apparatus of station 323, before the pallet 338 is introduced into its entrance 342. The clamp 345 forming part of the mobile equipment 346 of said station grips the workpiece 347 which has stopped against the edge 348 of the receptacle 349 forming both part of the station and an extension of the supply channel 327 of the container 321. After the mobile equipment 346 carrying the workpiece 347 has risen, the pallet 338 is introduced into the entrance 342.

The station 323 comprises a first part 351 assigned to the drives and controls, and a second part 352 assigned to automatically handling the workpiece 347.

The station 331, shown to the right of Figure 13, and served manually, comprises a first part 353 of the same general arrangement as the part 351, but does not comprise the part 352.

It is thus possible to use an assembly such as shown at 331 to which the workpieces are manually fed, or a totally automatic station to which the workpieces are automatically fed.

The station 331 may be preceded by a buffer store 355 in direct communication with the pallet circulation path 356. The buffer store is designed to receive the pallets 338 which accumulate upstream of the station 331 when their number exceeds a predetermined value. The buffer store 355 is of generally parallelepiped form, with its inner face 357 open for communication with the path 356.

The rail 361 (Figure 17) which guides the pallets 338 is interrupted opposite the store device 355, this gap being made up by a rail part 362. When the rail part 362 is completely filled with pallets, the arrival and halting of the next pallet in front of a sensor 363 (Figure 12) provides a signal which, by comparison with a signal indicating the continuation of circulation of the chain, causes a jack to operate so that its rod transversely displaces the rail portion carrying the pallets into a position shown diagrammatically at 366. Under these conditions, a further rail portion 367 carried by the jack rod enters between the ends 368 and 369 of the rail 361, the arrangement being somewhat analogous to that described heretofore with reference to Figure 7.

The pallets continue to arrive, and the rail portion 367 progressively becomes filled. When it is completely full, and as explained heretofore with relation to the portion 362, the comparison between the signal provided by the sensor 363 and a signal indicating the continuation of the driving movement causes the portion 367 to be displaced transversely to bring it into the buffer store in the position indicated by the line 366, whereas the portion 362 arrives in the storage device in the position indicated by the line 371. A third rail portion 372 is then in the gap between the ends 368 and 369 of the rail 361.

The number of rail portions may be greater or less than that described, according to the storage capacity of the storage device.

When the operator resumes his work, the store empties by an operation the reverse of that described heretofore with reference to its filling. In this embodiment, the cross member, plate and entrance constitute a sub-assembly.

Whereas the mobile equipment 346 is shown in Figure 13 in its lowered position, which represents the position in which it grips a workpiece in the receptacle after the channel, it is shown in Figure 15 in an intermediate position. In Figure 18, the mobile equipment 346 is shown in a raised position, the clamp 383 being above the entrance 342.

In the station 331, the mechanisms for introducing the pallet into the entrance are controlled in the same manner as in the completely automatic station 323.

The embodiment shown in Figure 19 is very similar to that shown in Figures 11 and 12. It comprises an automatic station 391 on one of the sides of the enclosure 309. The panel 392 enables the correct operation of the station to be checked at any time. The button 393 controls its manual and automatic operation and its stoppage.

The indicating lamp 394 gives warning, on lighting, that the gap between one station, for example the station 334, and the upstream

station 331, is completely filled with pallets 338 touching each other. The lighting of the indicating lamp 394 is controlled by the sesor 394'.

The opposite side comprises an automatic station 395 with a supply container 396, and a station 397 comprising the same control means for introducing the pallets into an entrance. The pallet in the entrance is within reach of an operator located in front of the table 332.

Figures 20 and 21 show a further embodiment. In this embodiment, the machine is generally circular in plan view and comprises a circular base 450 resting on the ground via pads 451 of adjustable height, a column 452 rising from the centre of the base. A central pillar 453 extends from the column, and is advantageously hollow to allow the passage of ducts or conductors. On this pillar is rotatably mounted a toothed wheel 454, the toothing 454' of which extends only over part of the height of the wheel and cooperates with a peripheral chain 453'. The chain is double, and its top part drives pinions 452' carried by pallets 455 the bodies 456 of which comprise two branches 457 and 458. A plate 459 is connected to the body 456 of each pallet. A disc 461 is rigid with the toothed wheel 454, the disc periphery comprising radial notches 462 uniformly distributed angularly. These notches may be engaged by two pins 463 and 464 carried by a disc 465 rotated by an electric motor 466 about an axis different from the axis 477 of the pillar 453 but parallel thereto.

The branches 457 and 458 of the body 456 of a pallet embrace a circular rail 467 centered about the axis 477. Opposite a working station, the rail 467 comprises a gap made up by a rail portion 470 rigid with a carriage 468 slidably mounted in grooves 469 and 471 in the branches 472 and 473 of a radial cross member 474 fixed to the pillar 453 by half collars 475 and 476. The carriage 468 carries a second rail portion 478 closer to the axis 477 of the pillar 453.

The rod 479 of a jack 481 carried by the radial cross member 474 is coupled to the carriage 468. Columns 482 and 483 are fixed to the end of the branches 472 and 473, and support two parallel platforms 484 and 485 forming part of an entrance 486 and bordering a gap 487. The platforms 484 and 485 have their inner edges provided with groves 489 and 491.

A circular plate 490 is fixed on the pillar 453. It carries at its periphery, in positions opposite each station, two pneumatically operated stop devices 492 comprising a cylinder 493 and piston 494, the end of the rod of this latter constituting a stop for a circulating pallet when the piston rod is in its projecting position. For this purpose, each pallet comprises a rib 495 projecting from its upper face, in order to cooperate with the rods of stop devices when these latter are in their projecting position.

When the motor 466 rotates, it drives the disc 461 and toothed wheel 454, via the pins 463 and 464, with a movement which is a sinusoidal function of time, the distance between two successive sine curves being equal to the distance separating the parallel edges 496 and 497 of a pallet.

The pallets 455 are rotated when the pinion which they carry engages with the top part of the double chain, the pinion being friction mounted on the pallet body. Each of the pallets is guided by the branches 457 and 458 of its body 456 straddling the rail 467. The front edge 498 of the pallet slides against the inner surface of a skirt extending over the entire periphery of the apparatus.

A pallet arrives opposite a working station at zero speed and with its body straddling a rail portion 470. The jack 481 is operated, and the pallet is displaced radially outwards, its longitudinal edges engaging in the grooves 489 and 491 in the entrance. At the end of this movement, the second rail portion 478 is in the gap between the adjacent parts of the rail 467, and re-establishes the rail continuity.

A station is generally of the same arrangement as that of the previous embodiments. The stations are spaced apart angularly by a whole multiple of the pallet width.

The various working stations are formed with a basic structure which is identical for all stations, and the specific purpose of the station is determined by the choice of head or working assembly carried on the columns 482 and 483.

With reference to Figures 19a to 21a, in this embodiment the entrance 701 comprising the receptacle 702 for containing the plate 703 of the pallet 704 is formed in a block 705 carried by the columns 706 and 707 constituting the structural members of the working station. These latter are fixed to the end of the branches 708 and 709 of the beams 711, which are connected together by a strut 712. The tool support equipment 713 is constituted by a parallelepiped block 714 slidably mounted along the columns 706 and 707, and subjected to the action of the mobile member 715 of a jack or press 716 carried by a bar 717.

This arrangement is particularly advantageous where the press develops a large force.

Such a station construction can be used, whether the machine has a circular plan, or whether the circulation circuit comprises two parallel rectilinear arms connected to one another.

In the embodiment shown in Figures 30 and 31, the pinion 801 carried by a pallet 802 comprises two bearing plates 803 and 804, A resilient device 805 bearing against the body

806 of the pallet urges the pinion 801 against the plate 807.

The teeth 808 of the pinion are pointed, to facilitate re-engagement in the links 809 of the chain 820.

In the embodiment shown in Figure 32, the structure of the machine comprises a longitudinal beam 811, and the tool-carrying device 812 is actuated by rams 813 and 814. The arrangement of the station is similar to that already described with reference to Figures 19a to 21a.

In Figure 33, a pallet 802_1 faces the entrance 815 with its rib 816_1 in abutment with a retractable stop 817a. The following pallet 802_2 is in abutment with a stop member 817b.

In the embodiment shown in Figures 34 to 36, the station 851 includes a vertical storage unit 852 for components, constitued by a stack 853 open at its lower aperture 854, The latter faces a pushing or feeding device 855 having a cylinder 856 and piston 857, The carriage 858 with the rail sections 859 and 861 has an offset portion 862 ending in two fingers 863 between which is a space for passage of the rod 864 of the piston 857.

In the condition shown in Figure 34, the gripper 860 holds a component p placed on the plate 865 of the pallet. In the condition shown in Figure 35, the gripper-carrying device 866, operated by the ram 867, has raised the component p. The carriage 858 has been moved so that the fingers 863 are directly below the component p. By lowering the gripper-carrying device 866, the component p is placed on the fingers 863.

By an opposite movement of the carriage 858, the component p, resting on the fingers 863, is brought opposite the lower apperture 854 of the stack 852.

In the condition shown in Figure 36, a further component p' has been brought by the plate 865' to a position below the gripper 860. The component p is in a position in which it can be introduced into the stack 852 by the action of the piston 857.

The machine thus equipped is adapted for carrying out a manufacturing operation or an assembly operation at one or several stations, even if one of the stations is temporarily out of action.

With reference to Figures 22 to 25, the automatically operating apparatus, which is of controlled operation, may form part of a machine comprising several automatically controlled apparatus. Diagrammatically, it comprises a carriage M (Figure 22) designed to be moved in one direction or the other along a horizontal stroke the ends of which are indicated by a and b (Figure 23).

The carriage M carries a head T.

At the ends a and b of the stroke of the carriage M, the head T may be separated from the carriage and moved along two vertical strokes, ac and bd respectively.

The head T is provided with a clamp P able to assume two states, an open state shown by a full line in Figure 22, and a closed state shown by a dotted line.

This automatic apparatus is able to seize a piece in a container e, the point c being inside the container e, and deposit it on a transfer pallet f adjacent to the stroke end d.

Three sensors are provided at each of the points a, b, c, d, and cooperate respectively with the carriage M, the head T and clamp P. The sensors corresponding to the carriage and head are activated when the carriage or head is in their immediate proximity, and the sensor associated with the clamp is energised when the clamp is in one of its two states, for example the closed state.

In the arrangements shown, the stroke end a is at the top left, this being indicated by assigning the letter G to the carriage sensor m in proximity to the stroke end a, and the letter H to the sensor t. The stroke end b is at the top right.

The operation control device comprises a panel consisting of a plate 515 (Figure 24) on which vertical lines 516 and horizontal lines 517 are drawn to define the rows and columns. Light emitting diodes 518_1, 518_2 etc. are disposed behind a transparent appendix 515a to the plate 515, in the extension to each of the rows.

The diode 518_1 is connected to the sensor m D, the reference letter m being used here to indicate that the sensor cooperates with the carriage M, and the reference letter D is used to indicate that the sensor operates when the carriage is in its extreme right position.

The diode 518_2 is connected to the sensor mG, the reference letter G being used to indicate that the sensor operates when the carriage has reached the left end of the stroke.

The diode 518_3 is connected to the sensor tH, the reference letter t being used to indicate that the sensor cooperates with the head, and the reference letter H is used to indicate that the sensor operates when the head is in its raised position.

The diode 518_4 is connected to the sensor tB. the reference letter B being used to indicate that the sensor operates when the head is in its lowered position.

The diode 518_5 is connected to the sensors p so that it becomes energised when the sensors p cooperate with the clamp P in its closed condition.

The diode 518_6 is connected to said sensors p so that if becomes energised when said sensors cooperate with the clamp in its open position.

Other horizontally aligned light emitting diodes 521 are disposed behind a further transparent appendix 519 to the plate 515,

the various diodes 521 being opposite each of the columns defined by the vertical lines 516.

The diode 521_0 is energised when the drive for the automatic apparatus corresponds to the initial state of this latter, or the "0" state.

The diode 521_1 is energised when the drive for the automatic apparatus corresponds to the "1" state of this latter, etc., and the diode 521_8, which is the last in the row, is energised when the drive for the automatic apparatus corresponds to the "8" state, the described arrangement being provided for an automatic apparatus operating cycle comprising eight states.

The vertical lines 516 and horizontal lines 517 define a certain number of rectangular divisions 533 at their intersection, and some of these divisions are transparent and others are opaque in accordance with the progress of the various operations of an automatic apparatus.

Advantageously, the panel or plate 515 is of an opaque sheet material, and transparency of the required rectangular divisions is obtained by simple punching. In Figure 24, diagonal lines have been drawn on the transparent divisions. The divisions not comprising diagonal lines are opaque.

In the state shown in Figure 24, the light emitting diode 521_0 is lit, this being indicated by the circle symbolising the diode being filled in, and the other diodes 521 are unlit, this being indicated by the circles representing them not being filled in. The lit diode 521_0 indicates that the automatic apparatus is in its "0" state.

The first horizontal row opposite the diode 518_1 is associated with the right hand position of the carriage M, this being indicated by the word "carriage" being written in a legend division 522 provided as an extension of said horizontal row, and by the word "right" in an adjacent legend division 523 also as an extension to said row. Opposite the immediately lower horizontal row, extending from the diode 518_2, the division 524 under the division 523 carries the word "left". The two divisions 523 and 524 are adjacent to the division 522 which is therefore double the height of each of the divisions 523 and 524.

The next horizontal row opposite the diode 518_3 terminates in a division 525 carrying the word "raised", and this division is immediately above a division 526 carrying the word "lowered". The divisions 525 and 526 are adjacent to a division 527 of double height carrying the word "head".

The immediately lower division 528, of the same height as the division 527, carries the word "clamp". It is opposite two divisions 529 and 531 carrying the words "closed" and "open" respectively.

Divisions 532, 532', 534, 535, 536, 537 are adjacent to the divisions 523, 524, 525, 526, 529, 531 respectively, and the signs written there, namely the signs + and −, indicate the information contained in the divisions 523, 524 etc.

The letter A indicates the carriage. The letter B indicates the head. The letter C indicates the clamp.

For the carriage, the sign + in the division 532 indicates its right hand position, and the sign − in the division 532' indicates its left hand position. For the head, the sign + in the division 534 indicates its raised position and the sign − in the division 535 indicates its lowered position. For the clamp, the sign + in the division 536 indicates its closed state and the sign − in the division 537 indicates its open state.

The reference numerals for the various transparent or opaque rectangular divisions 533 carry a first index which indicates their column number and a second index which indicates their horizontal row number. For example, the division 533.0.1 is in the same column as the diode 521_0 and in the same row as the diode 518_1. The division 533.2.1 is aligned vertically with the diode 521_2 and horizontally with the diode 518_1.

The operation of the automatic apparatus can therefore be checked at a glance. The only requirement to be satisfied is that at each operating stage of the automatic apparatus, as indicated by the corresponding diode 521 lighting, only those diodes 518 must light which are horizontally aligned with the transparent divisions 533 of the column corresponding to said stage, and those diodes 518 horizontally aligned with the non-transparent divisions of said column must remain unlit. This requirement is really obvious, and is very easy to check.

If a diode 518 aligned horizontally with a transparent division of the column above the lit diode 521 does not light, this indicates defective operation.

Distinguishing the transparent or opaque state of the divisions 533 may be facilitated by disposing a light source under the panel 511 comprising the plate 515.

In Figure 24, the diode 521_0 is lit, as indicated by it being filled in, and the other diodes are consequently unlit. The operator will observe that in the column lying above the diode 521_0, the divisions 533.0.2, 533.0.3 and 533.0.6 are transparent. He now checks that during this stage corresponding to the lighting of the diode 521_0, the diodes 518_2, 518_3 and 518_6 light. If these diodes light, then the automatic apparatus is operating normally during this stage.

During this stage, or "0" stage, the carriage M must be on the left hand side, and thus cooperating with the sensor mG, which lights the diode 518_2. The head T must be in its raised position cooperating with the sensor tH, to light the diode 518_3.

The clamp P must be in the open state, as sensed by the sensor p.

If during the stage indicated by the lighting of the light emitting diode 521_0, one of the diodes 518_2, 518_3 and 518_6 does not light, the operator is informed that there is a malfunction. If during this stage a diode 518 other than the diodes 518_2, 518_3 and 518_6 lights, he draws the same conclusion.

If operation is normal, as checked by the operator in the aforesaid manner, the light emitting diode 521_0 goes out and the light emitting diode 521_1 lights. The machine then commences its subsequent operating stage or stage "1". The method for checking the proper operation of the machine in this second stage is the same as described heretofore for stage "0".

Stage "1" of the apparatus is defined by the arrangement of the transparent windows 533 of the column above the diode 521_1. During this stage, the carriage M must remain at the left hand end of its stroke. The head T is in its lowered position and the clamp P must remain open.

The operator checks during this stage that the light emitting diode 521_1 is lit and that no other diodes 521 are lit, and that the diode 518_2 in the row corresponding to the transparent division $533_{1,2}$ of column 1, the diode 518_4 in the row corresponding to the transparent division $533_{1,4}$ and the diode 518_6 in the row corresponding to the division $533_{1,6}$ are lit, the other diodes 518 remaining unlit.

The following stage "2", differs from stage "1" only in that the clamp closes to grip a workpiece contained in the container e.

In the next stage, or stage "3" indicated by the diode 521_3 lighting, the carriage is on the left hand side, the head is in its raised position and the clamp is closed to hold the workpiece.

The transparent divisions of the columns 4, 5, 6, 7 and 8 define the operating stages 4, 5, 6, 7 and 8 of the automatic apparatus.

At any moment, the operator can thus check whether operation is correct, and if necessary can identify a fault.

The mimic diagram 515 comprises columns 9 and 10 to enable it to be adapted to an automatic apparatus with ten operating stages and not only eight as heretofore described.

The panel 511 may advantageously be carried on the upper face 541 of a parallelepiped box 542 enclosing the automatic apparatus.

The upper wall 541 of the box 542 comprises an indicating lamp 549 which lights when the apparatus is switched on. It also comprises a button 551, the three positions of which correspond respectively to automatic operation, manual operation and resetting to zero of the apparatus.

The lateral wall 543 comprises an arrangement 544 with three divisions 545, 546 and 547 corresponding respectively to the carriage, head and clamp, the corresponding symbols A, B, C being between the signs − and + respectively.

Opposite each division 545, 546 and 547, there are buttons, 548− and 548+ for the division 545, 548B− and 548B+ for the division 546, and 548C− and 548C+ for the division 547. By manually operating the button 548A−, the carriage moves towards the left, on manually operating the button 548A+ it moves towards the right, on manually operating the button 548B− the head moves downwards, on manually operating the button 548B+ the head moves upwards, on manually operating the button 548C− the clamp opens, and on manually operating the button 548C+ the clamp closes.

The various described components are identified on the device for monitoring the operation, by means of the same symbols or reference numerals as those carried on the control device. For example, for the head B, the sensors associated therewith will carry the letter B plus the sign + or the sign − depending upon whether they correspond to the raised or lowered position.

Likewise, the distributor, the action of which controls the rise and fall of the head, is identified by the letter B, with a+ or a− at one or other of its positions corresponding to the rise and fall of the head.

The printed circuit which controls the distributor is also given the same letter and the signs + or − according to which of the two positions defined heretofore it conveys the distributor into when operated.

The task of the operator is thus considerably facilitated when he notices a malfunction by observing the control device.

The apparatus also comprises means for allowing it to pass from one operating stage to the next operating stage only if its members have reached the required positions and/or states at the end of the first stage.

With reference to Figures 26 to 29, the automatic apparatus comprises an entrance 591 with two slides 592 and 593 comprising guideways 594 and 595. The members comprising the apparatus are enclosed in a box 601 formed from two metal plates 602 and 603 bent along lines 604 and 605, their edges 606 and 607 facing each other. Uprights 613 and 614 are mounted on the entrance members 592 and 593 by headed screws 611 and 612, these uprights being advantageously of a transparent material such as "Perspex" (registered Trade Mark) and fixed by studs 615 and 616 which traverse both the uprights 613 and 614 and

the entrance members 592 and 593. The uprights 613 and 614 comprise vertical channels 617 and 618 for slidably mounting a transparent panel 619. The lower part 621 of said panel is free, while the upper part over approximately two thirds of the panel height is covered by gluing a sheet 622 of non-transparent material carrying at its top a diagram 623 in the form of rows and columns.

The transparent panel 619 is traversed upperly by a rod 624 to which is connected a knurled head 625 within reach of the operator, the rod 624 being held by a circlip 626. This rod, when in the pasition shown in Figure 26, is inserted, advantageously via a rubber O ring, into a housing 627 comprising a block 628 rigid with the box.

Light emitting diodes 631 are disposed to the side of the vertical edge 629 of the diagram 623 opposite the various diagram rows. These diodes are advantageously fixed on a printed circuit board 632 forming part of a stack of boards supported by a printed circuit board 633. A horizontal row 630 of light emitting diodes borders the upper horizontal edge of the diagram 623.

A button 635 comprising a key 636 projects from the upper wall 634 of the box, and is arranged to switch the apparatus contained in the box 601 into an operating condition or a non-operating condition, an indicating lamp 637 lighting if the apparatus breaks down. A plate 645 rigid with a slide 646 of U cross-section, which guides it in its movement within the installation in passing from one automatic apparatus to the next automatic apparatus, is arranged for insertion into an entrance constituted by two slide members 592 and 593.

A cover 653 of transparent material is rotatably mounted about an axis 652 on an upright 641 of the apparatus by means of a corner plate 651. Said cover comprises two perpendicular branches 654 and 655, and is rotatably mounted at its other end on an upright of another apparatus of the installation which preceedes or follows the represented apparatus in the direction of movement of the pallets or plates 645.

The inner surfaces of the walls 602 and 603 are advantageously covered with an insulating layer 656 and 657 respectively.

In one position shown in Figure 26 and to the left of Figure 29, the transparent panel 619 is in its normal position for using the apparatus. Through its lower part 621 it enables the members in the box 601 to be observed.

The lower edge 659 of the panel 619 is then at the same level as the lower ends 657 and 658 of the uprights 613 and 614.

If for any reason the operator desires access to the inside of the box 601, he grips the knurled head 625 and pulls it. Because of the flexibility of the plate constituting the panel 619, the rod 624 becomes disengaged from its housing 627, and the upper edge 659 of the panel 619 escapes from the upper wall 634 of the box. The panel 619 can then be moved upwards, its lower end being guided in the channels 617 and 618. The panel 619 can thus be brought into the position shown to the right of Figure 29 and in Figure 28. This position is maintained by itself because of the flexibility of the plate constituting the panel 619, the inner face of the panel being urged against the front portion of the upper wall of the box. The rod 624 cooperates with said wall to prevent any untimely return of the panel 619 into its initial position.

When it is again required to cover the bay 661 which has been exposed by sliding the panel 619 upwards, the operator merely has to pull the head 625 towards himself from the position shown in Figure 28, to disengage the ros 624 from the upper wall 634 of the box and slide the panel downwards to return it into its initial position.

In the position shown in Figure 26 and to the left of Figure 29, the cover 653 covers that part of the circulation track or rail for the pallets or plates 645 lying between two successive apparatus or working stations. A cover 662 is shown as an extension to the cover 653 to lie over a track parallel to that covered by this latter.

In the position shown in Figure 28 and the right hand side of Figure 29, the cover 653 is raised. That part of the track or rail which this cover covers in its other position is thus accessible.

WHAT WE CLAIM IS:—

1. A transfer machine for assembling and/or machining workpieces, comprising several working stations distributed along a closed pallet circulation circuit equipped with a rail, and comprising also an endless drive means, passing in front each of the working stations, to which drive means are connected, by releasable coupling means, a plurality of workpiece support pallets disposed on the guiding rail, whereby the pallets may be individually, at predetermined points of the circulation circuit, uncoupled from the drive means and pulled out of the circulation circuit, characterized in that the individual working stations are offset from the circulation circuit and are equiped with pallet holding means also offset from the circuit, in each of which holding means a pallet may be introduced individually by a displacement means, after uncoupling from the drive means, for proper positioning in view of the assembling and/or the machining of the workpiece it carries, and from which the pallet may be returned to the same point of the circulation circuit where

the driving cooperation of the pallet with the drive means is re-established, and means are provided to allow the circulation of the other pallets on the circuit past the working station during the working operation performed in said station.

2. A machine as claimed in claim 1, characterised in that a working station comprises a control and drive assembly, at least part of which is housed within an enclosure enclosing the circulation circuit.

3. A machine as claimed in claim 2, characterised in that that part of a station associated with the machining and/or assembly is external to the enclosure.

4. A machine as claimed in claim 1, 2 or 3 in which the pallet circulation rail includes, in front of a working station, a rail portion which may be displaced transversely relative to the remainder of the rail.

5. A machine as claimed in claim 4, in which there is provided in front of a working station a second rail portion which assumes the initial position of the first mentioned portion when the latter is displaced transversely.

6. A machine as claimed in claim 5, characterised in that said second rail portion is a rail portion on which the pallets circulate.

7. A machine as claimed in claim 6, characterised in that said second rail portion comprises a stop means for the pallets arriving at said station.

8. A machine as claimed in claim 4, 5, 6, or 7 when dependent on claim 2 or 3, characterised in that when the rail portion carrying the pallet reaches the end of its transverse stroke, it is located in an external entrance of the enclosure.

9. A machine as claimed in claim 8, characterised in that the entrance comprises means for supporting the pallet against machining forces.

10. A machine as claimed in any preceding claim, comprising, in front of a working station, a sensor which cooperates with an arriving pallet for determining the further movement of the latter.

11. A machine as claimed in any preceding claim, in which the pallets are positively driven by the endless drive means, but may be halted while remaining connected to said drive means by virtue of a pinion disposed on the pallet and able to be made immobile by friction relative to the pallet.

12. A machine as claimed in claim 11, characterised in that the means for driving a pallet by the drive means chain or the like comprise means which become inoperative when the resistance to the forward movement of the pallet exceeds a predetermined value.

13. A machine as claimed in claim 11, characterised in that the drive means for the pallets give these latter a movement having a substantially sinusoidal velocity curve, the period of which is equal to the length of a pallet in its direction of movement or a whole fraction of this length.

14. A machine as claimed in claim 13, characterised in that the working stations are spaced apart by a multiple of the pallet length.

15. A machine as claimed in any preceding claim, characterised in that the pallets are spaced apart on the endless drive means by a whole multiple of the pallet length, which multiple may be zero.

16. A machine as claimed in any one of the preceding claims, characterised in that an apparatus for conveying the workpieces is associated with an automatic assembly station, means being provided for fixing the position of the workpiece to be assembled relative to the assembly device of the station.

17. A machine as claimed in claim 16, charaterised in that the device comprises means for conveying its operating member, along one and the same trajectory, into a first position for gripping workpieces in a supply channel, a second withdrawn position for enabling a pallet to enter the entrance, and a third position for depositing the workpiece on the pallet.

18. A machine as claimed in any one of the preceding claims, characterised in that a pallet is carried by a pallet support which straddles the circulation rail.

19. A machine as claimed in claim 18, in which the rail for the pallet circulation has at least one portion which is an arc of a circle, and comprising means in said portion of the rail for keeping the pallet supported on its various faces.

20. A machine as claimed in claim 19, characterised in that the outer pallet support face is curved to cooperate with sliding guide means concentric to the axis of the circular arc portion of the circulation rail.

21. A machine as claimed in any preceding claim, comprising a drive and control assembly arranged to control the transverse displacement of a pallet towards an automatic machining and/or assembly unit or towards a table for manual assembly and/or machining.

22. A machine as claimed in any preceding claim in which the several working stations have identical structures and each comprises a beam transverse to the circulation circuit and provided with two branches on which are suspended columns forming part of the structure of the station.

23. A machine as claimed in claim 22 in which the means for transversely displacing a pallet towards a working position are carried by the beam.

24. A machine according to claim 22 in which an entrance for receiving a pallet is

formed in a block fixed on the columns.

25. A machine according to claim 22 in which means for assembling or machining a workpiece are carried by a block slidable on the columns.

26. A machine according to claim 25 in which means for machining a workpiece are mounted movably on the block.

27. A machine as claimed in claim 25 in which the block carrying the machining means is subject to the action of a press acting parallel to the two columns and midway between these.

28. A machine as claimed in claim 22 in which the circulation circuit is horizontal and circular, the structure of the machine comprising a central pillar and radial beams.

29. A machine as claimed in claim 28 in which the pallets are moved with a substantially sinusoidal velocity curve by a notched disc which cooperates with pins of a disc driven by an electric motor of which the axis is parallel to that of the circular circulation of the pallets.

30. A machine as claimed in claim 29 in which each pallet is moved by means of a pinion carried by the pallet and meshing with a chain passing round a toothed wheel.

31. A machine as claimed in claim 30 in which the pinion is mounted on the pallet by way of a force-limiting means.

32. A machine as claimed in claim 30 in which the toothed wheel is surmounted by a fixed plate carrying, facing each of the stations, stops engageable by the pallets.

33. A machine as claimed in any preceding claim in which a said station comprises a storage area for workpieces to be machined and/or assembled, and means for transferring work pieces to and from circulating pallets.

34. A machine as claimed in claim 33 in which the storage area is a vertical stack, and a carriage for moving the pallet transversely towards the station has an edge region arranged to come below the bottom of the stack.

MARKS & CLERK,
Charterd Patent Agents,
Agents for the Applicants.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon) Ltd. 1981. Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

1593738 COMPLETE SPECIFICATION
18 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

Fig.5

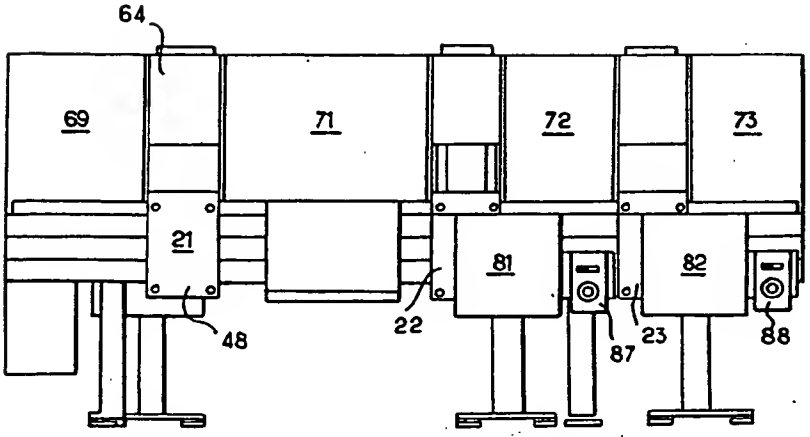
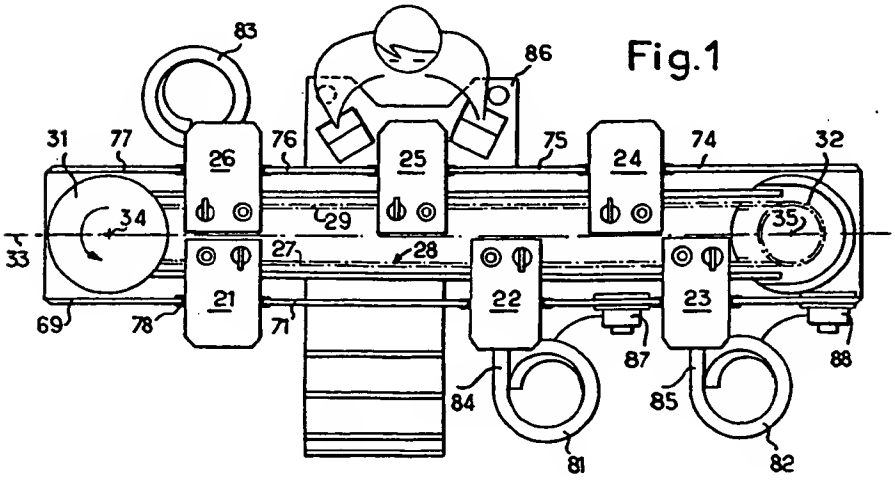
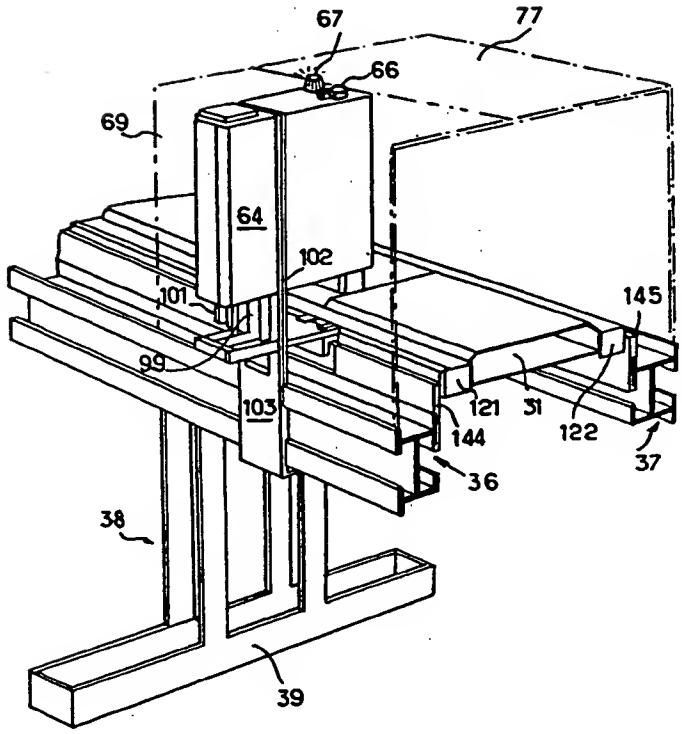


Fig.1



1593738 COMPLETE SPECIFICATION
18 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

Fig. 2



1593738 COMPLETE SPECIFICATION
18 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 3

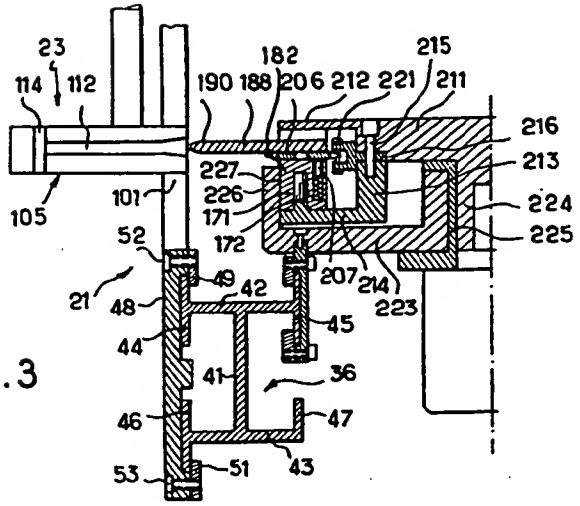


Fig.3

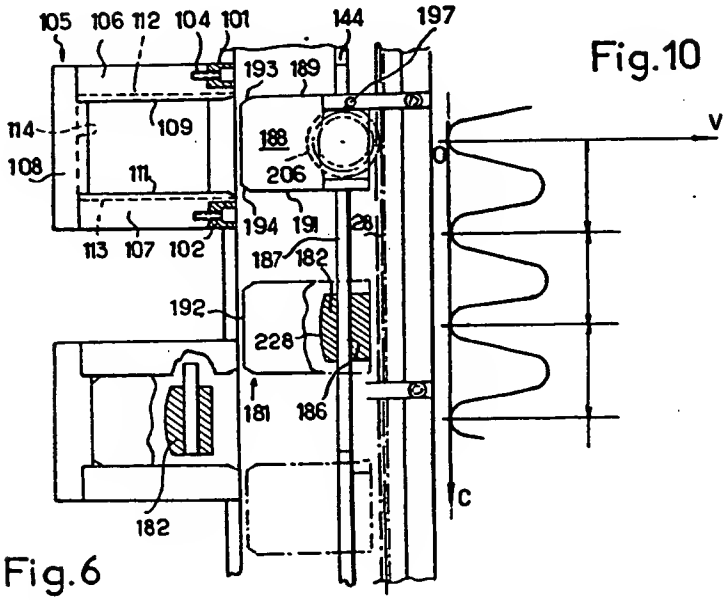
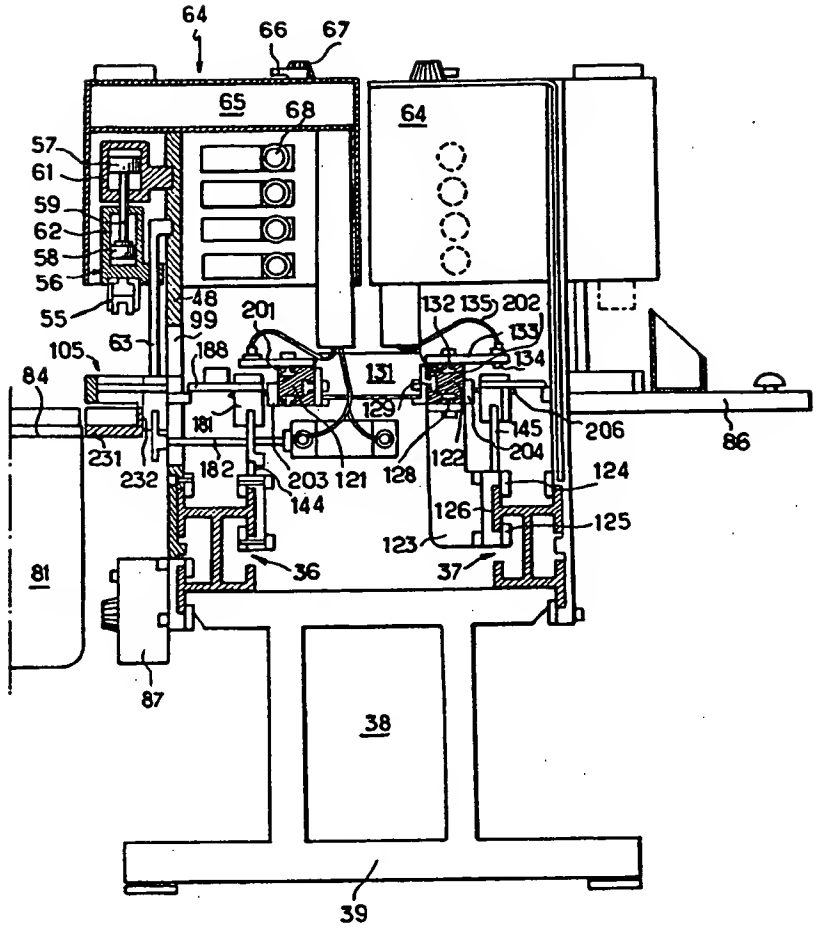


Fig.6

Fig.10

1593738 COMPLETE SPECIFICATION
18 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 4

Fig. 4



1593738 COMPLETE SPECIFICATION
18 SHEETS This drowing is a reproduction of the Original on a reduced scale
Sheet 5

Fig. 8

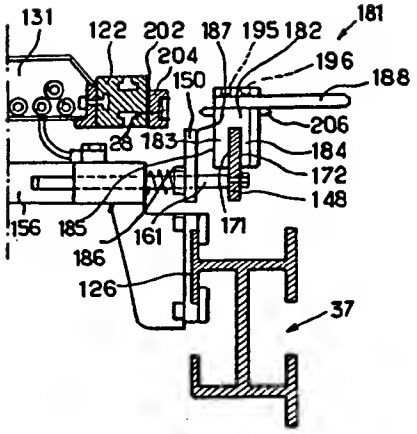
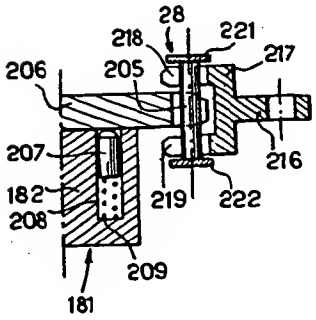


Fig. 9



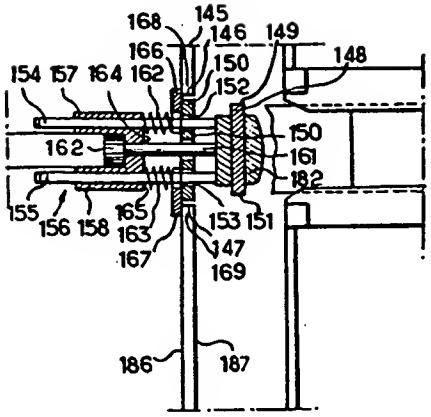
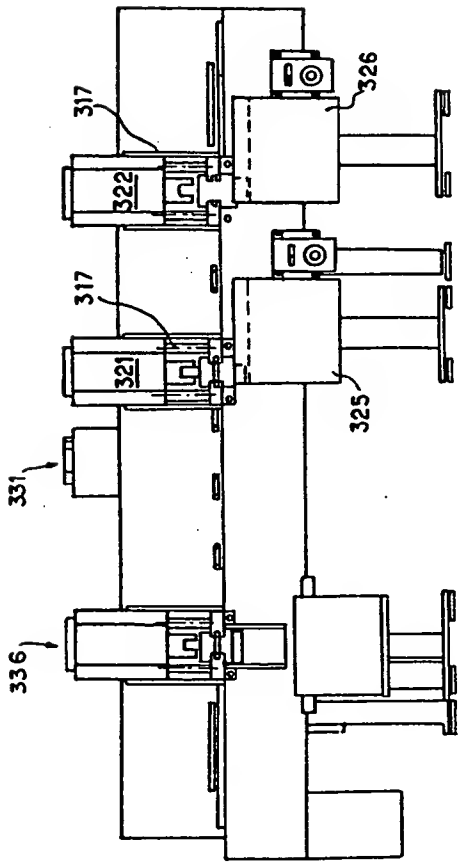


Fig. 7

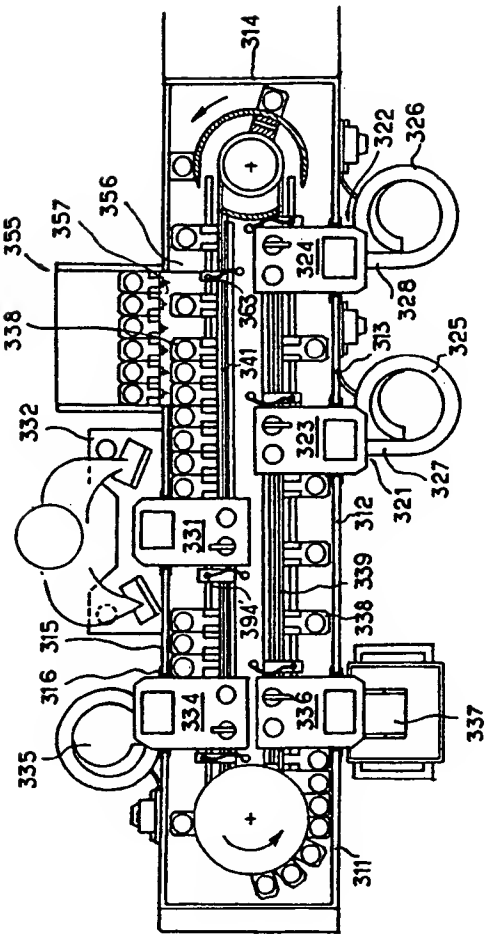
1593738 COMPLETE SPECIFICATION
18 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 6

Fig. 11



1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 7

Fig. 12



1593738 COMPLETE SPECIFICATION
18 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 8

Fig.13

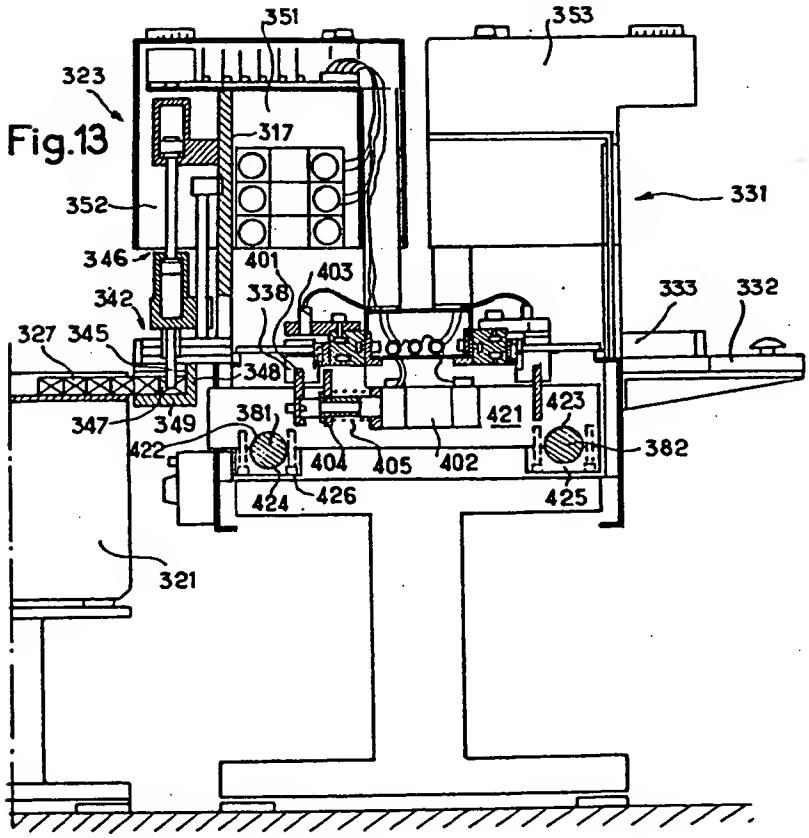
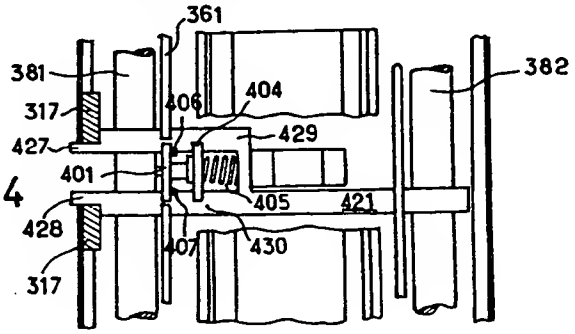


Fig.14



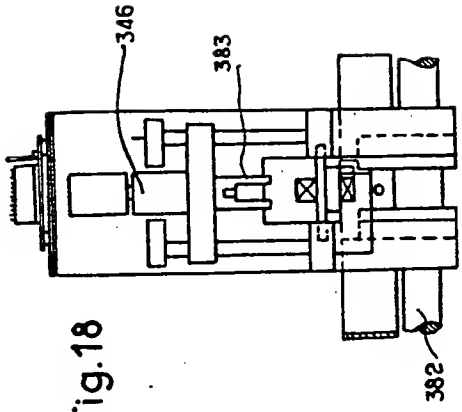


Fig.18

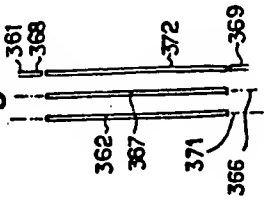


Fig.17c

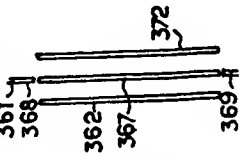


Fig.17b

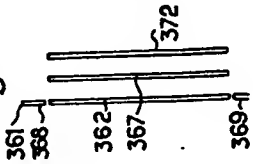


Fig.17a

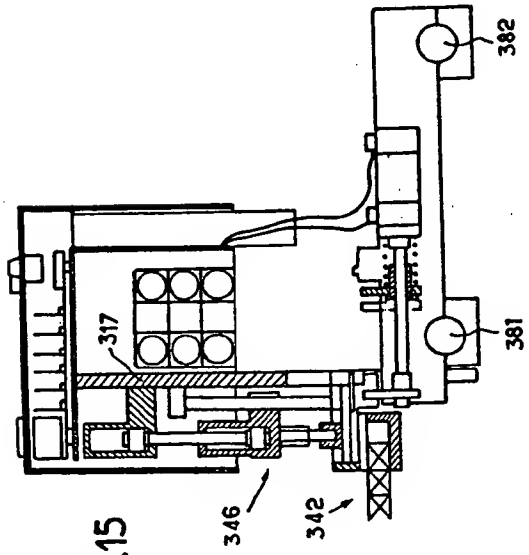


Fig.15

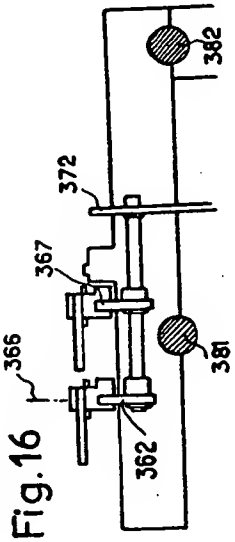


Fig.16

1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 10

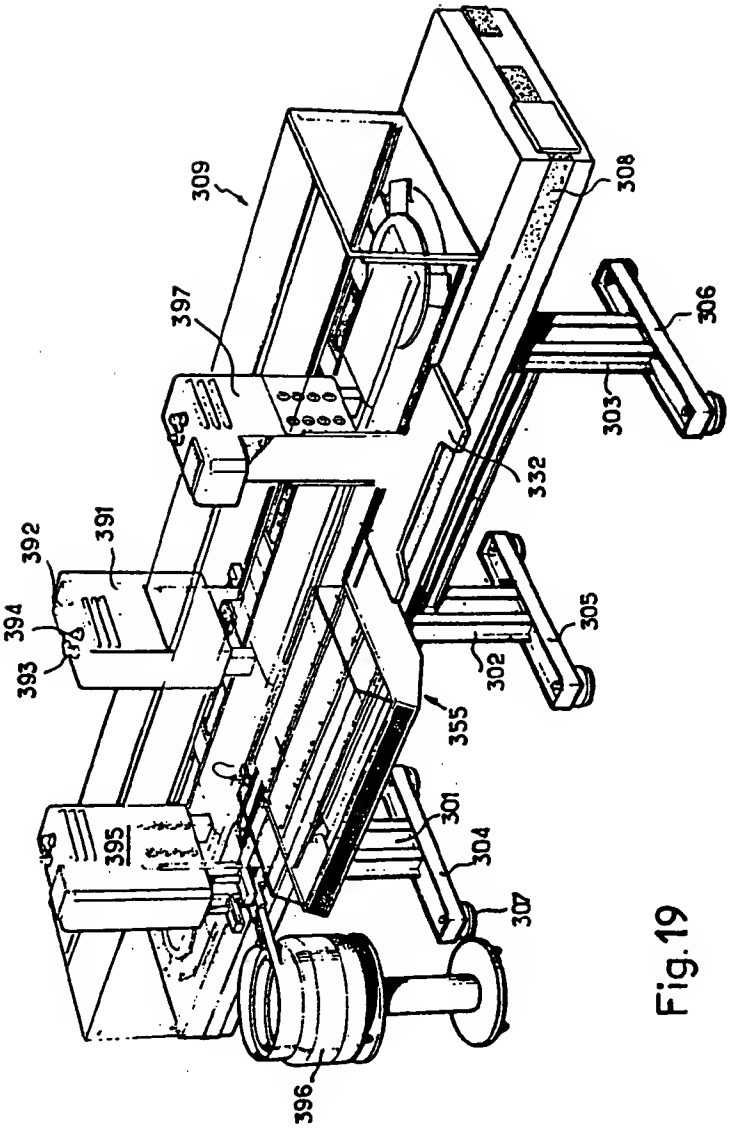


Fig.19

1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 11

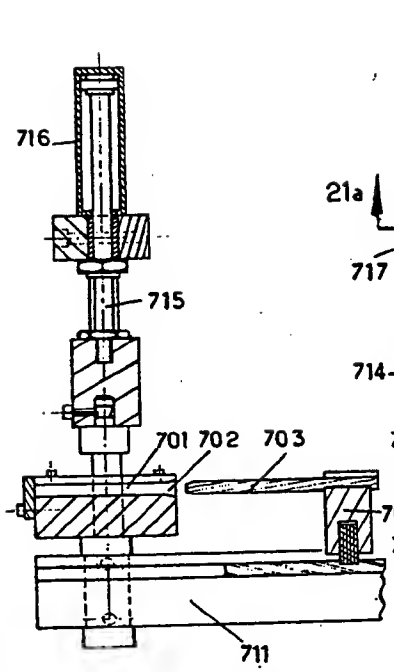


Fig. 20a

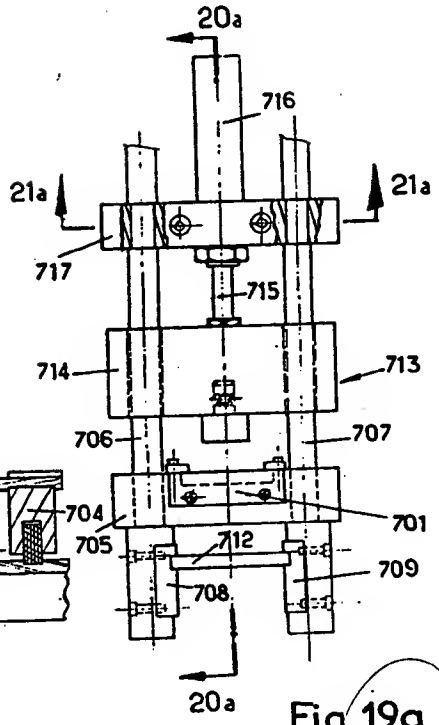


Fig. 19a

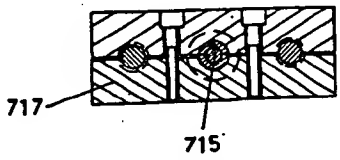


Fig. 21a

1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 12

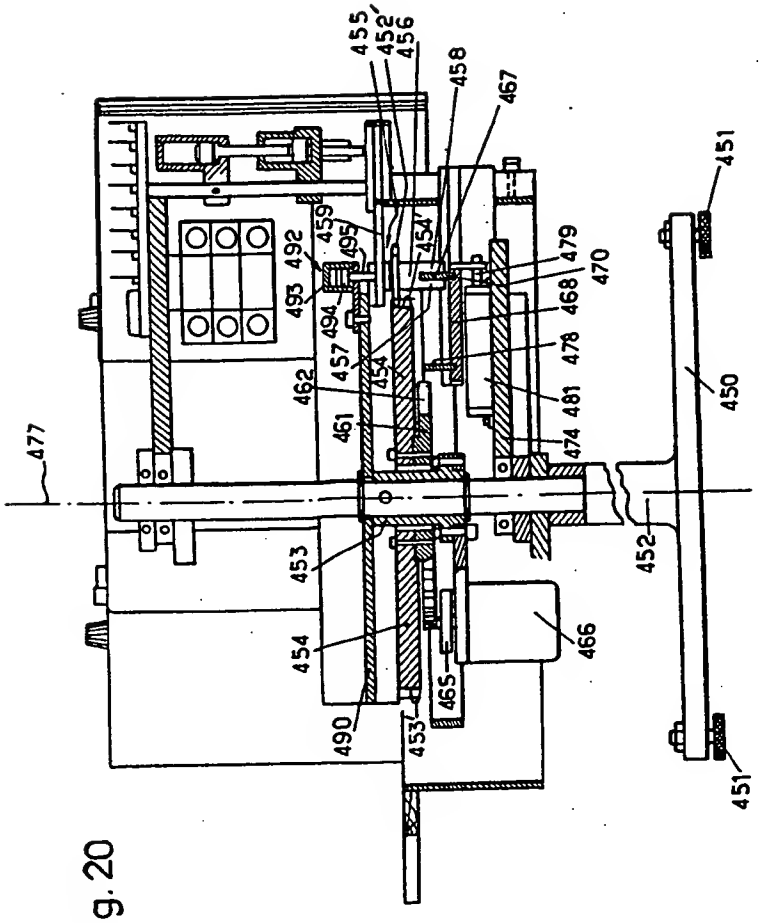


Fig. 20

1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 13

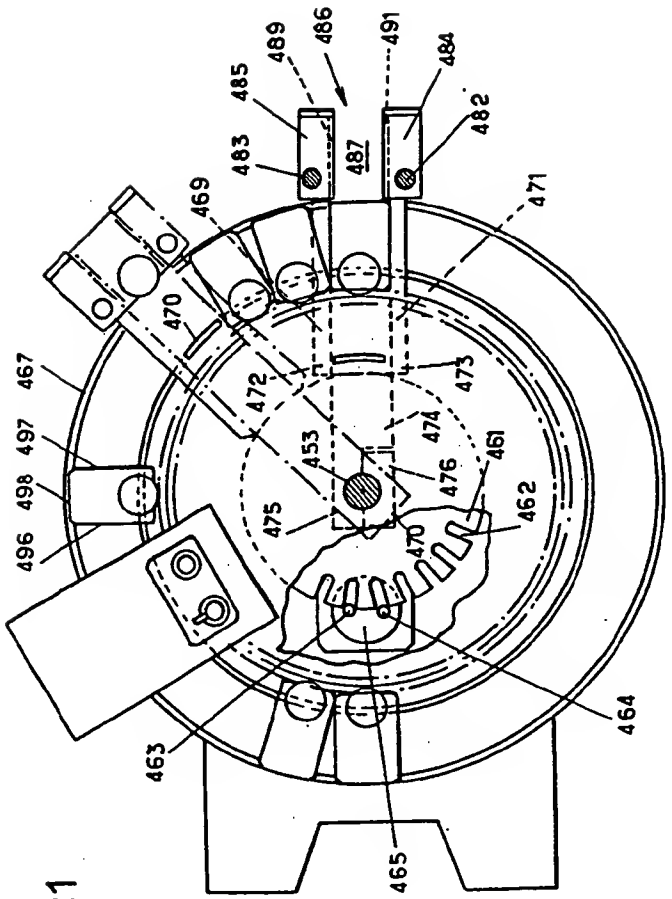


Fig. 21

1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 14

Fig. 23

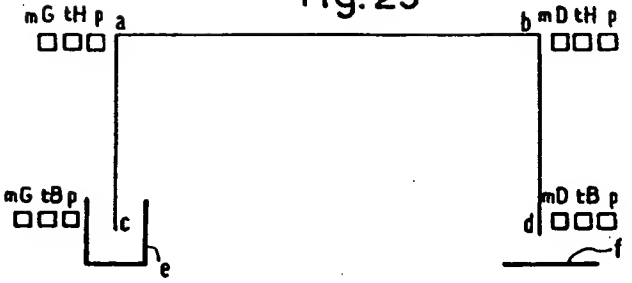


Fig. 22

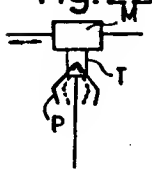
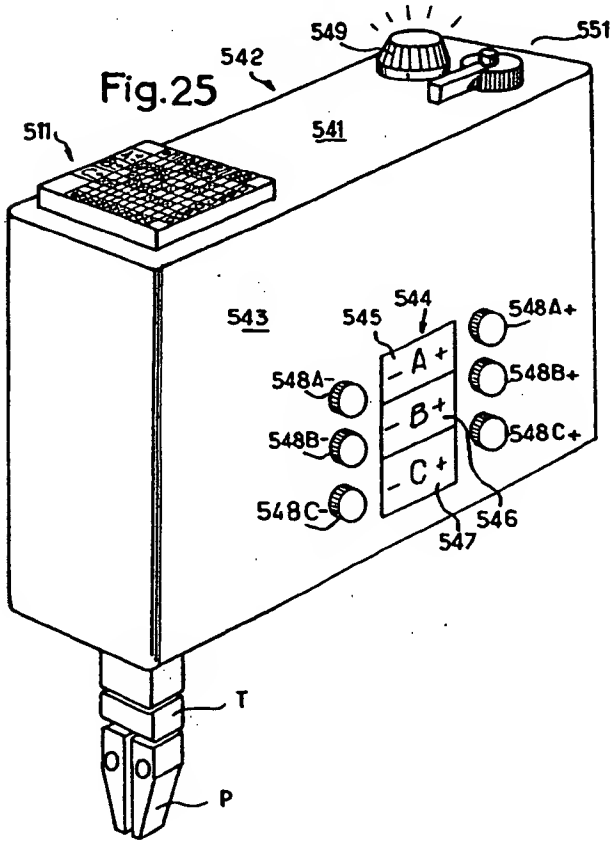
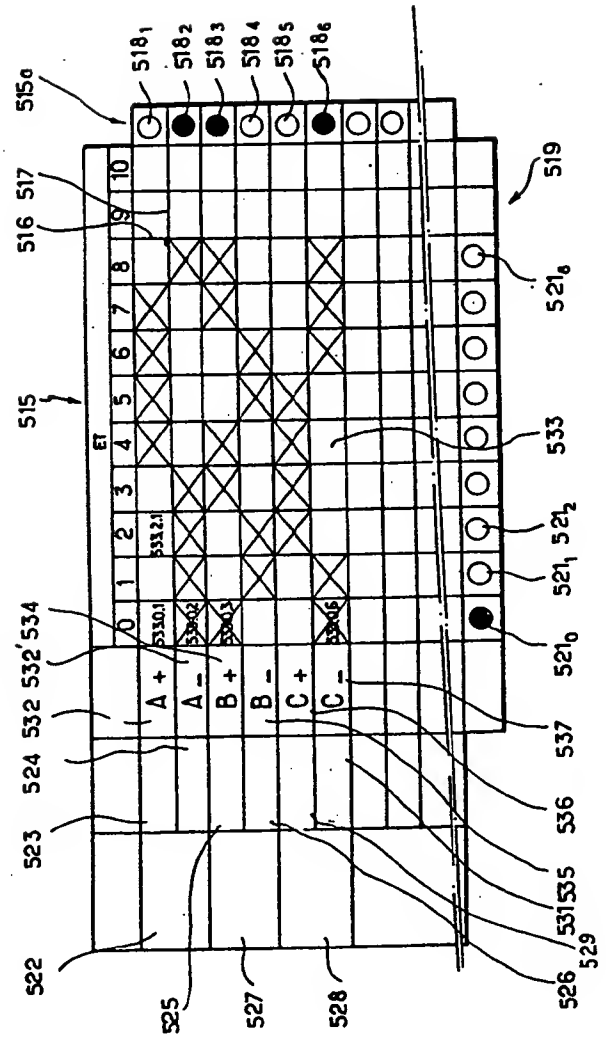


Fig. 25



1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 15

Fig. 24



1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 16

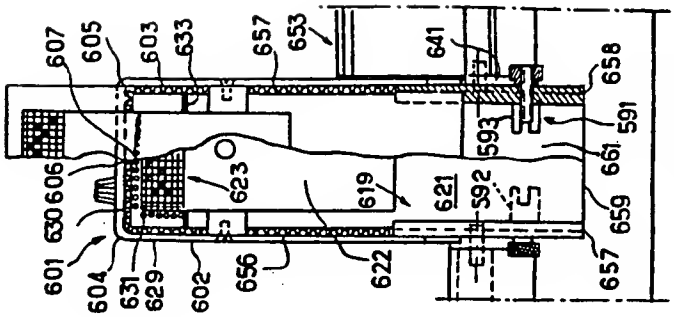


Fig. 29

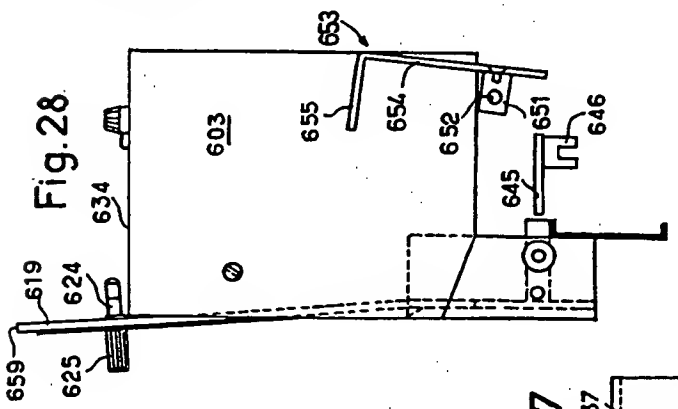


Fig. 28

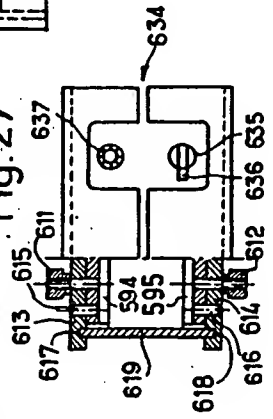


Fig. 27

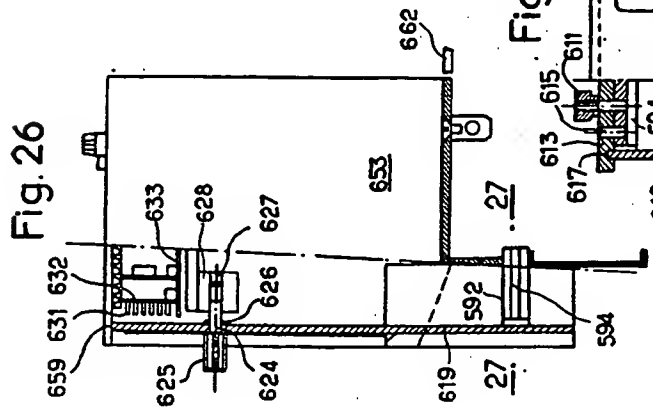
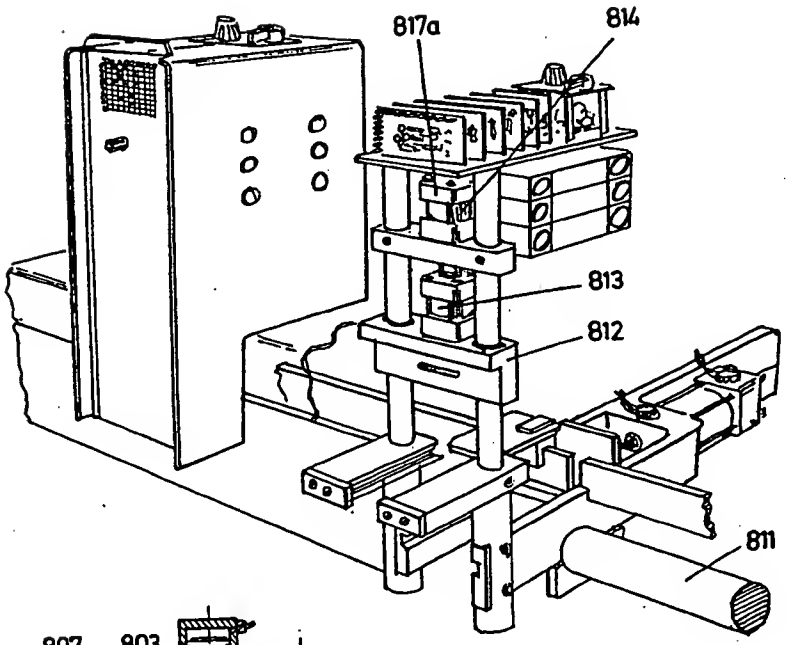


Fig. 26

1593738 COMPLETE SPECIFICATION
18 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 17

Fig. 32



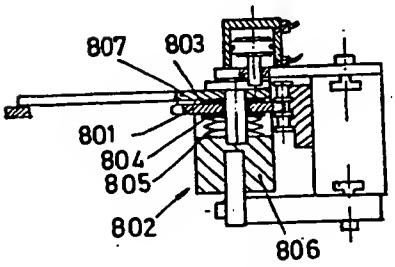


Fig. 30

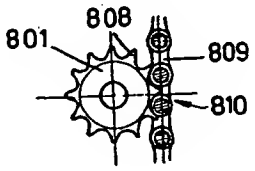


Fig. 31

1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 18

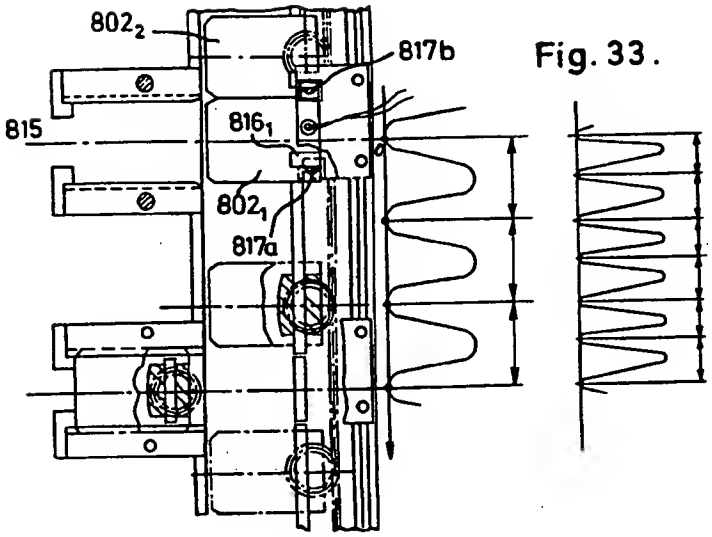


Fig. 33.

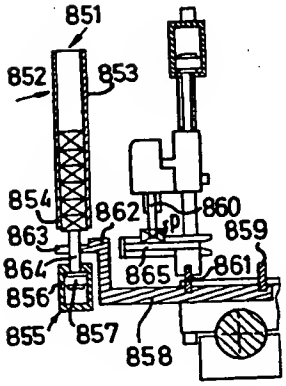


Fig.34

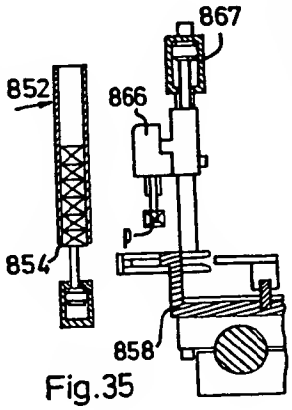


Fig.35

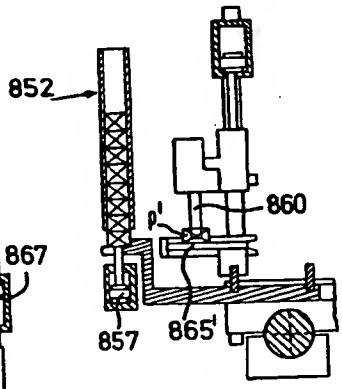
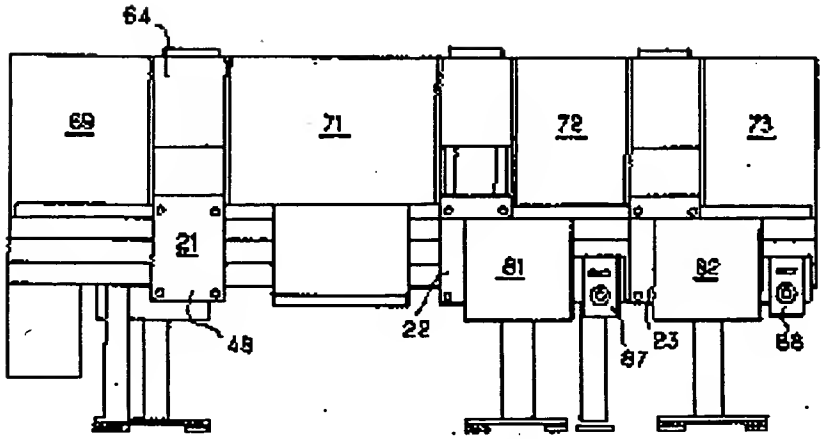


Fig.36

1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

Fig.5



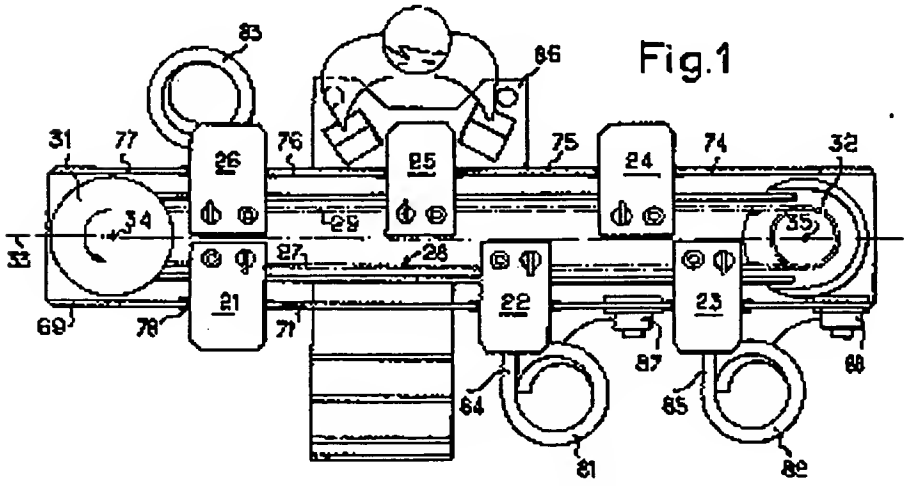
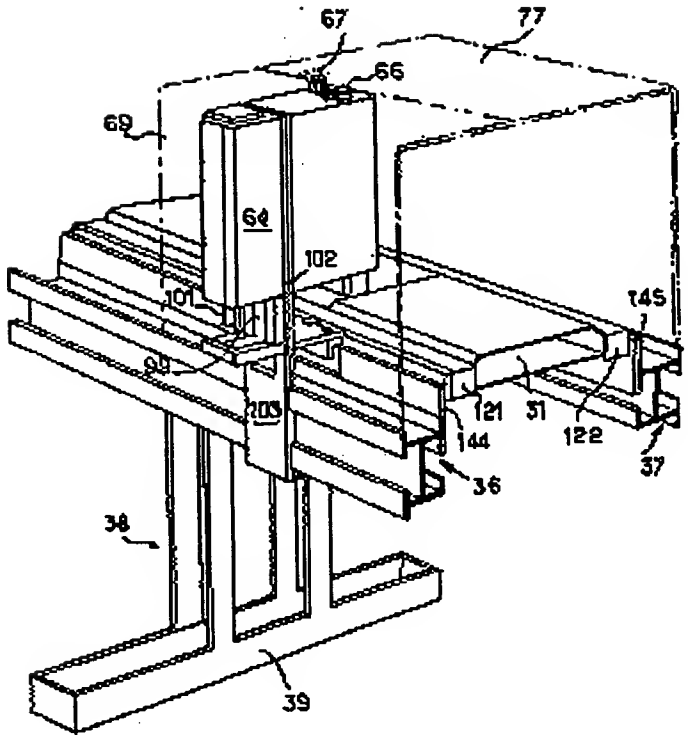


Fig.1

1583738 COMPLETE SPECIFICATION
16 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 2

Fig. 2



1593738 COMPLETE SPECIFICATION
16 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 3

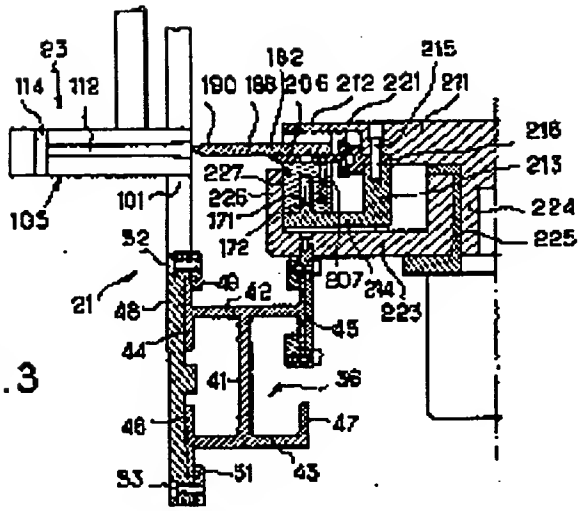


Fig.3

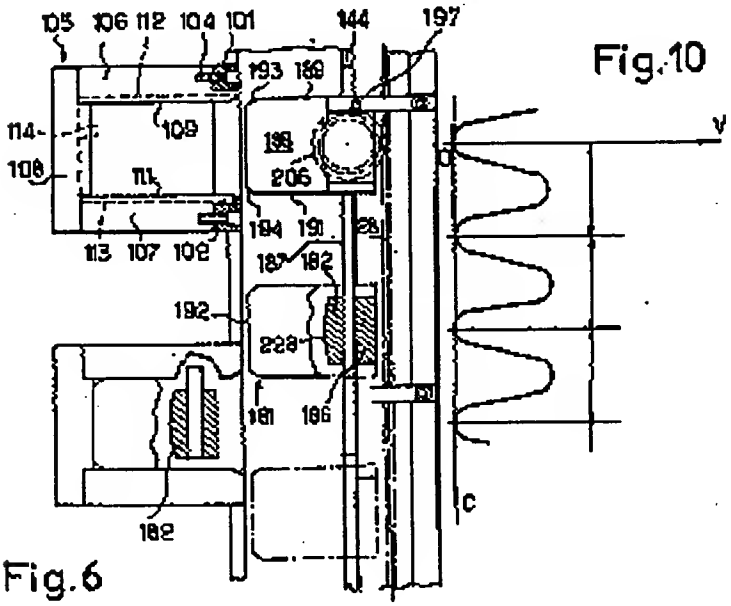
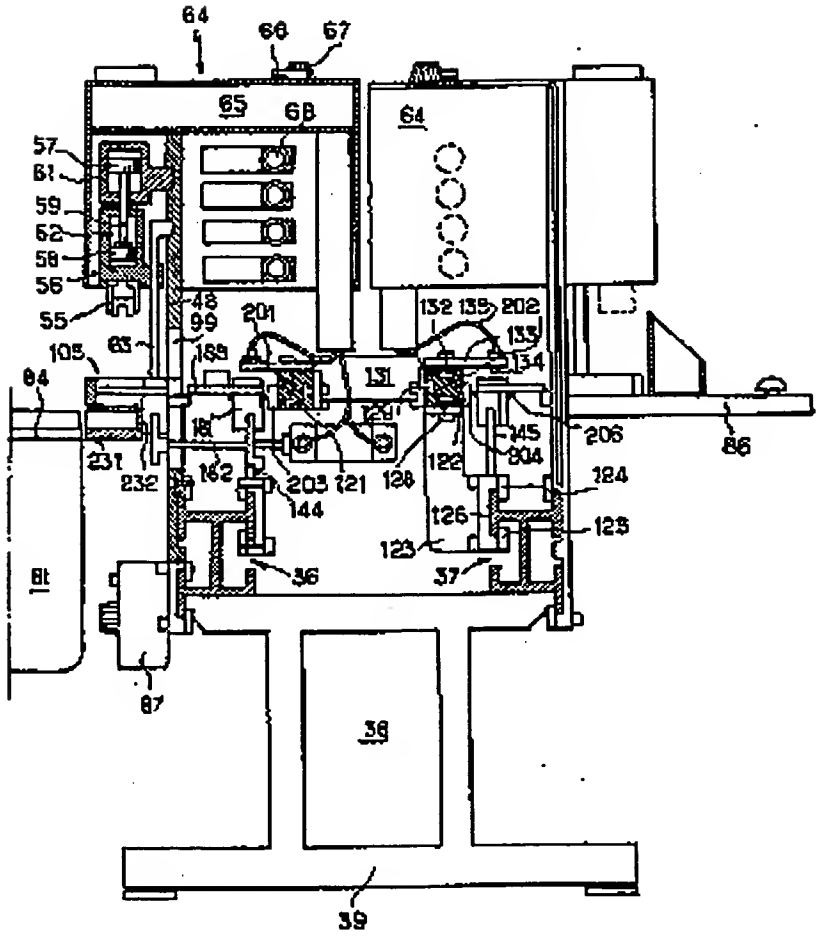


Fig.6

Fig.10

1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 4

Fig. 4



1583738 COMPLETE SPECIFICATION
16 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 5

Fig.8

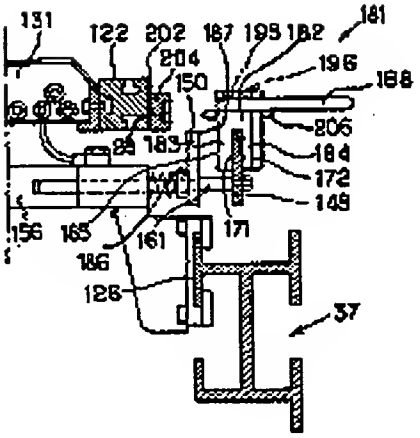
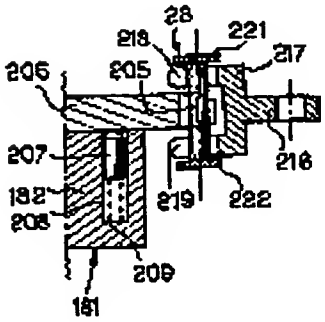


Fig. 9



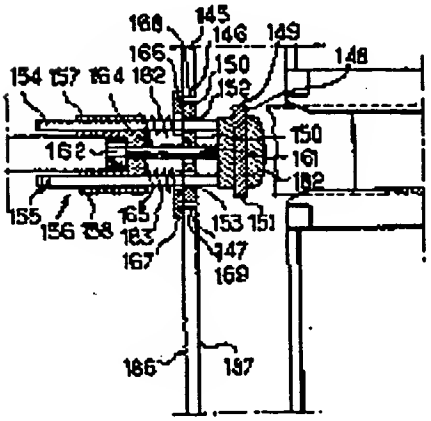


Fig. 7

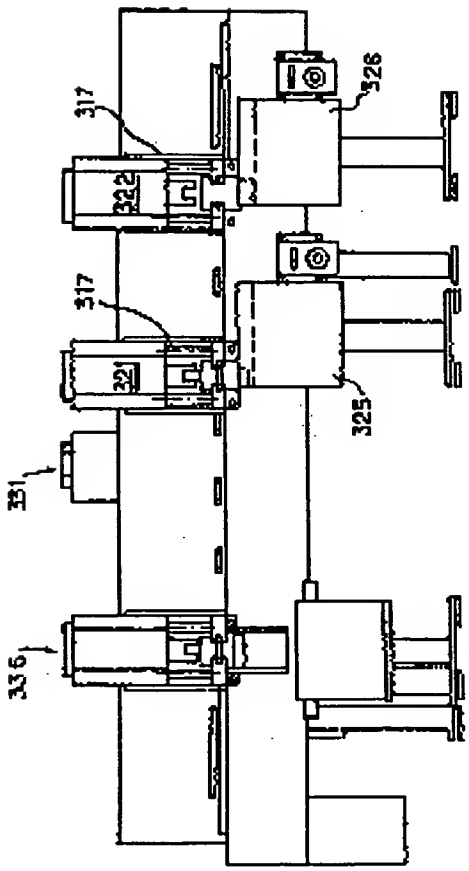
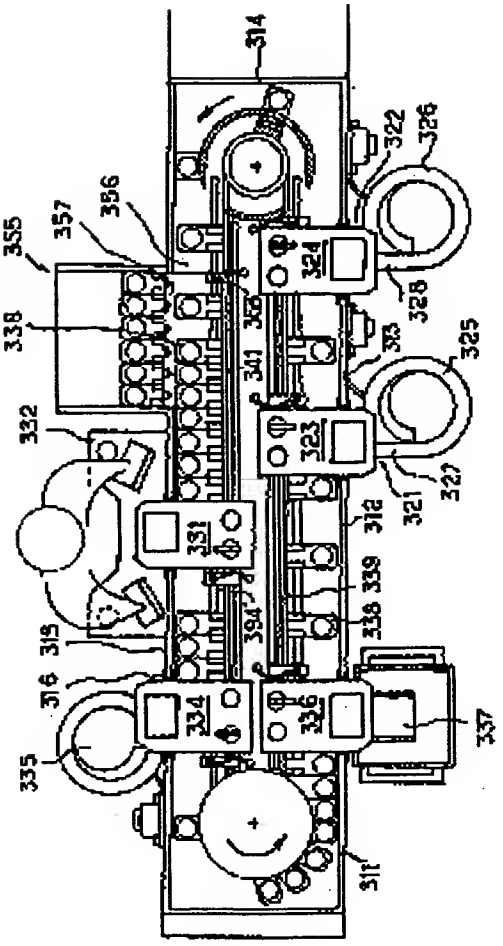


Fig. 11

1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 7

Fig. 12



1593798 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 8

Fig.13

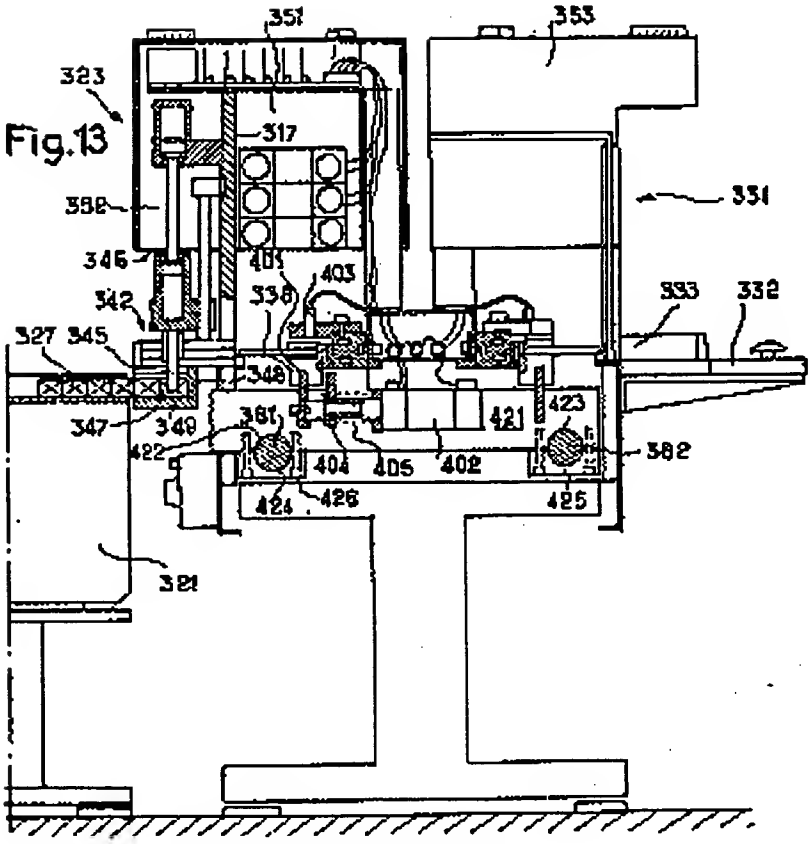
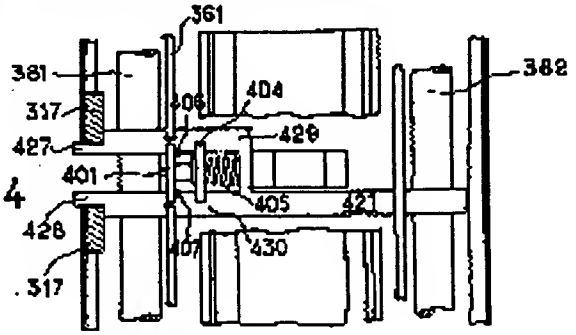


Fig.14



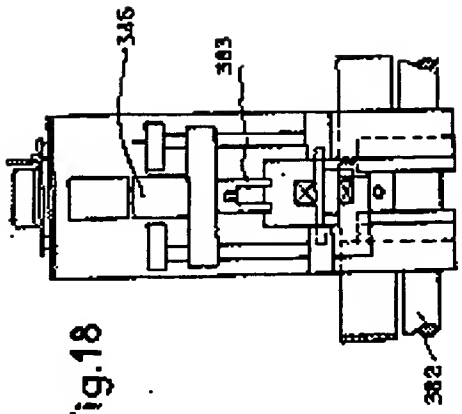


Fig.18

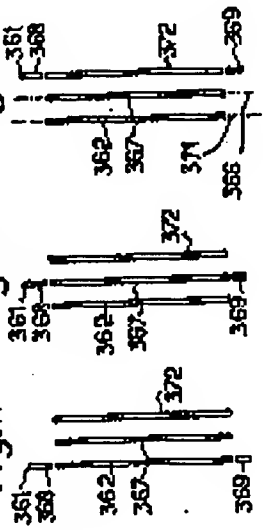


Fig.17c

Fig.17b

Fig.17a

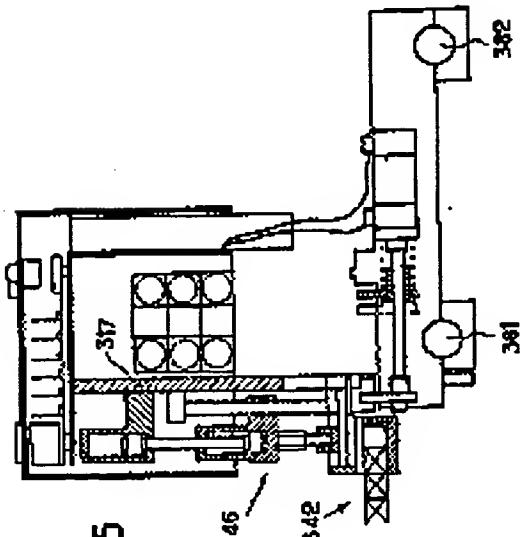


Fig.15

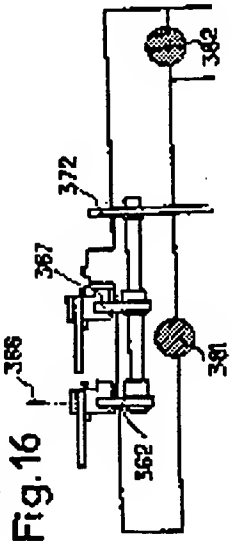


Fig.16

1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 10

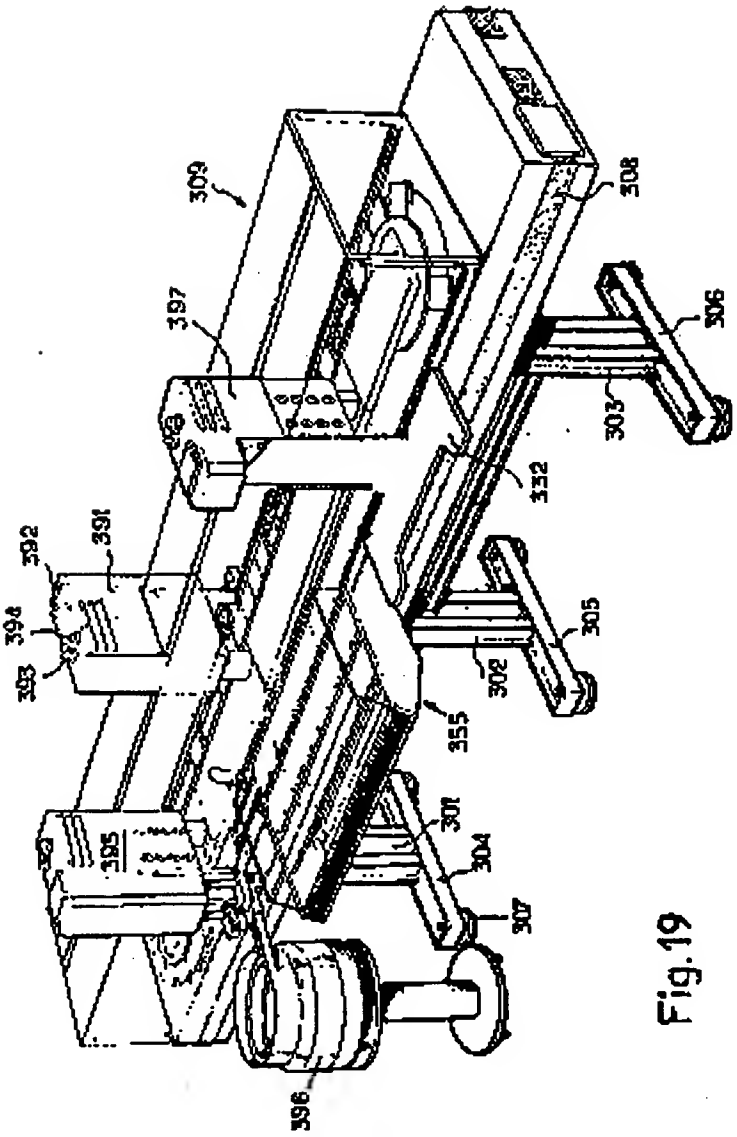


Fig.19

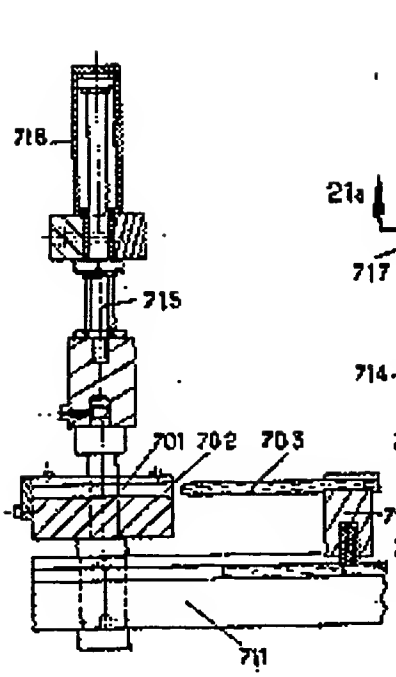


Fig. 20a

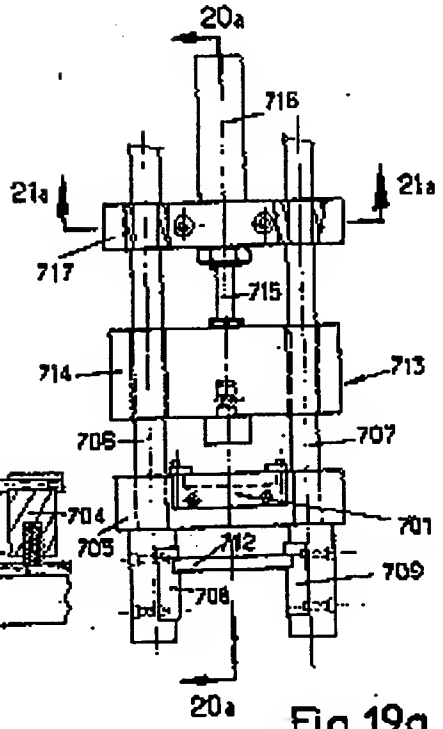


Fig. 19a

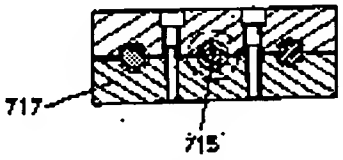


Fig. 21a

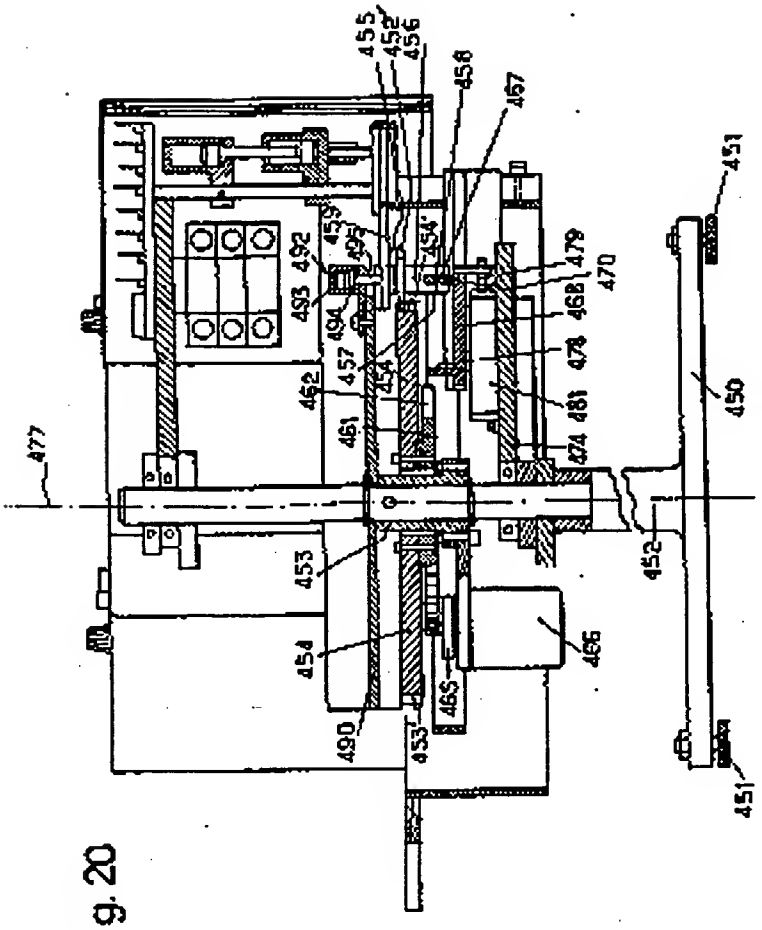

455
452
456
458
457
451
459
492
479
470
493
494
468
457
478
462
454
481
461
474
450
477
453
452
454
466
465
490
453
451

Fig. 20

1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 13

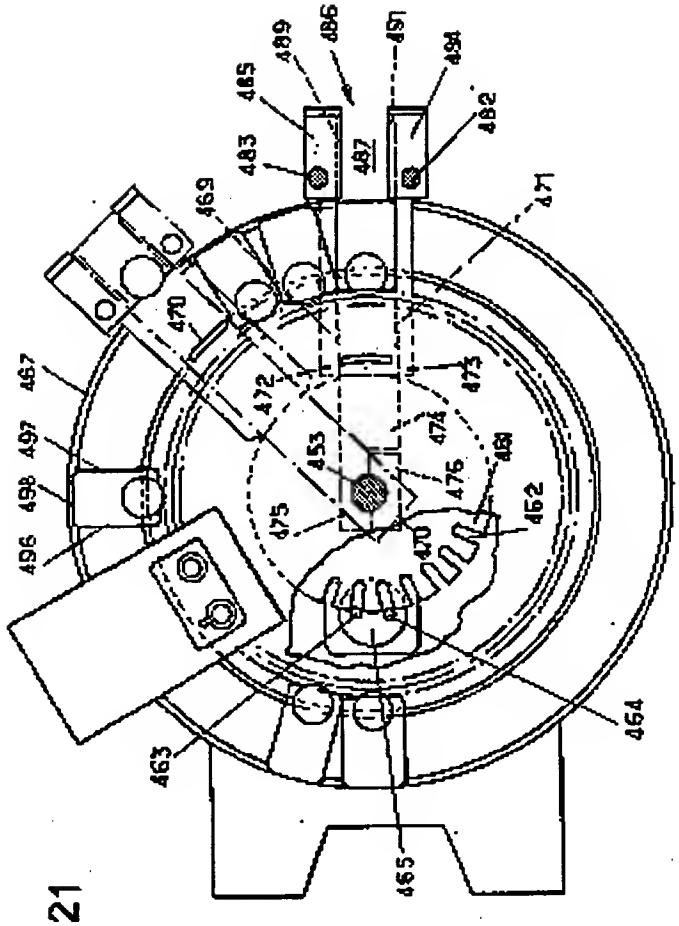


Fig. 21

Fig. 23

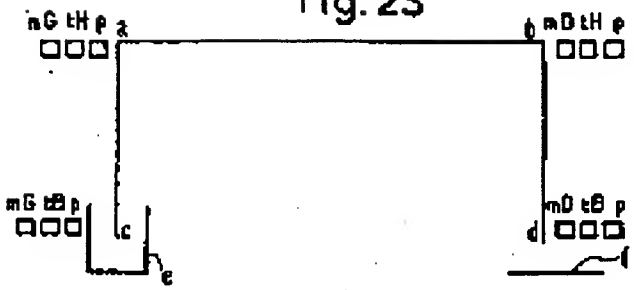


Fig. 22

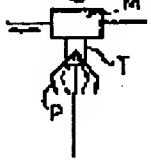


Fig. 25

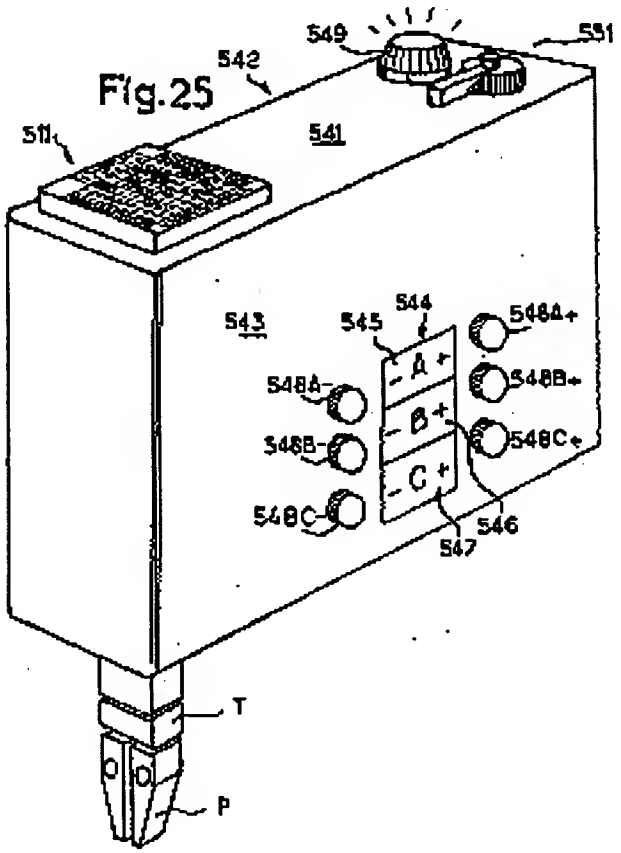
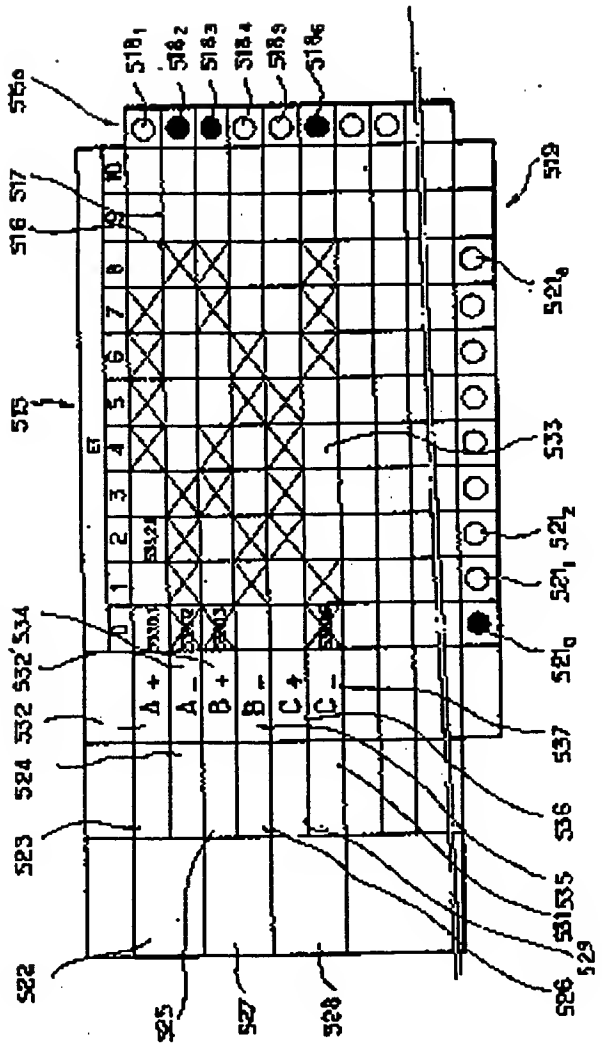


Fig. 24


516
517
515
534
532'
532
524
523
522
525
527
528
519
533
537
536
529
526
A+
A−
B+
B−
C+
C−

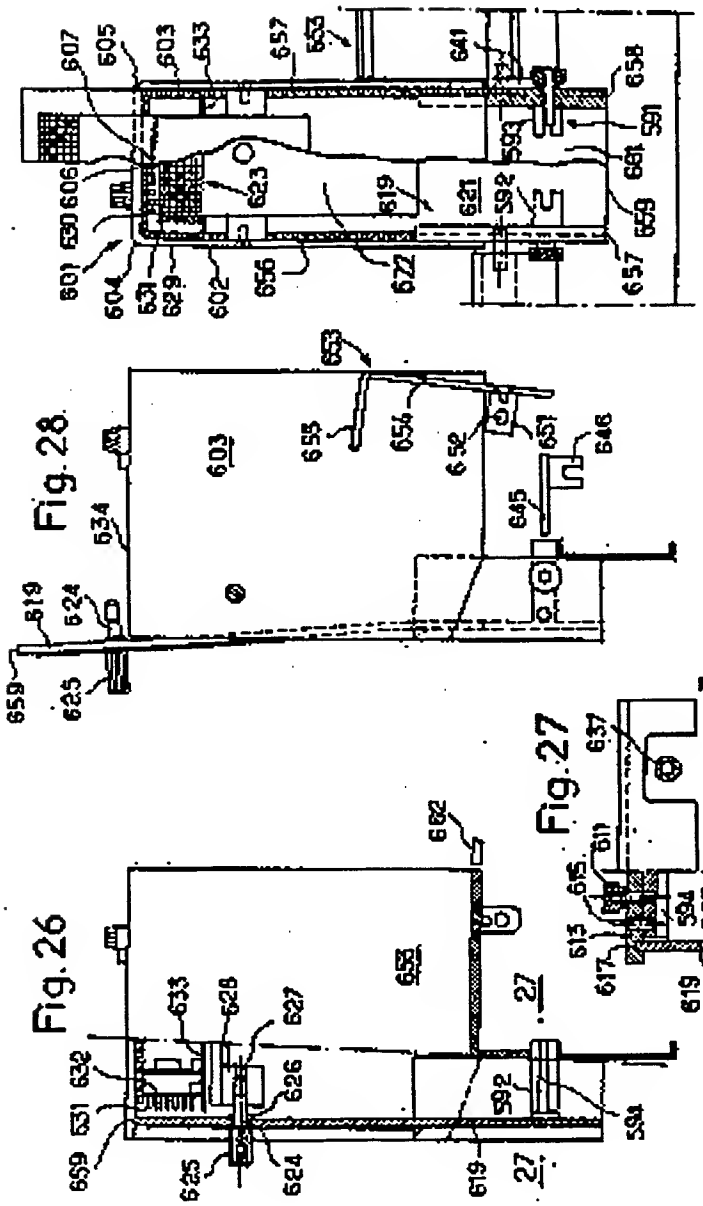
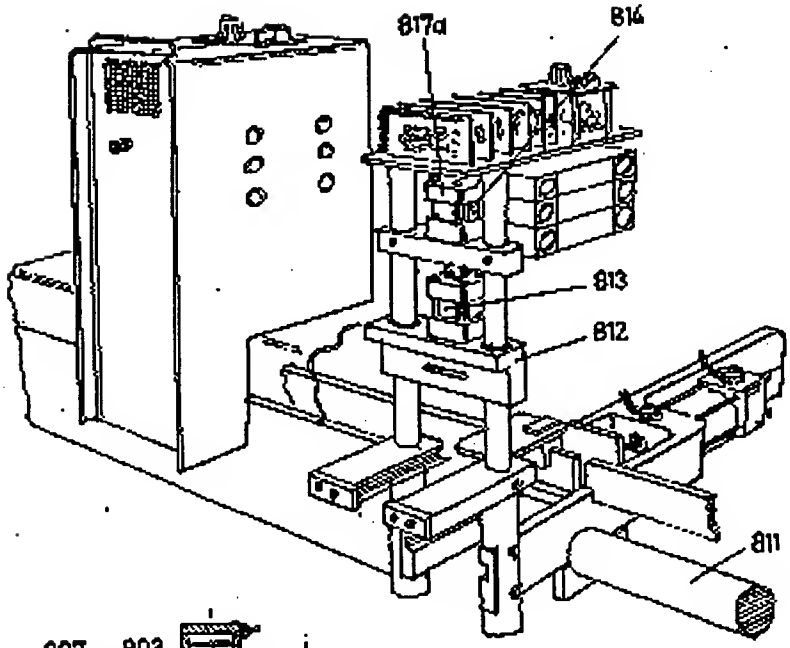


Fig. 29
Fig. 28
Fig. 27
Fig. 26

Fig. 32



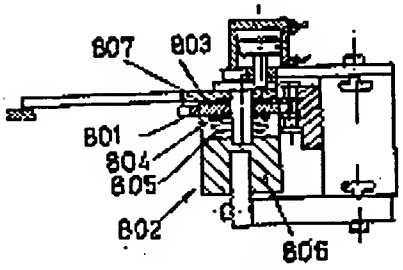


Fig. 30

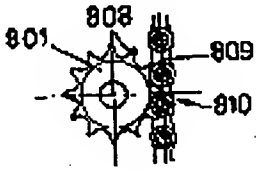


Fig. 31

1593738 COMPLETE SPECIFICATION
18 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 18

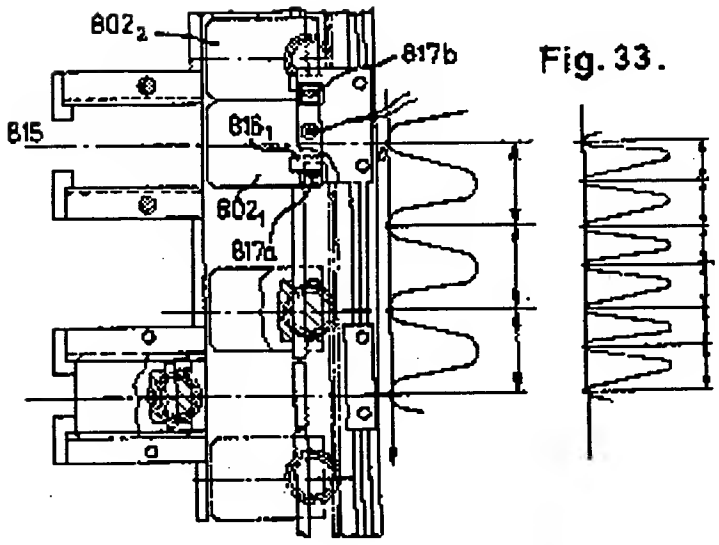


Fig. 33.

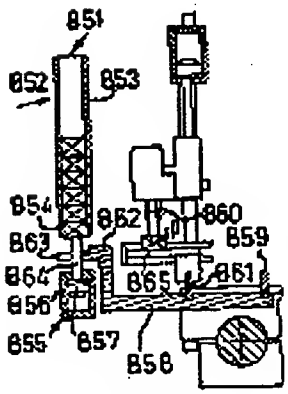


Fig. 34

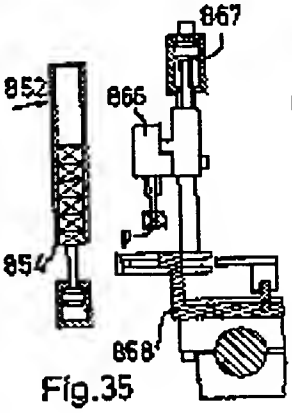


Fig. 35

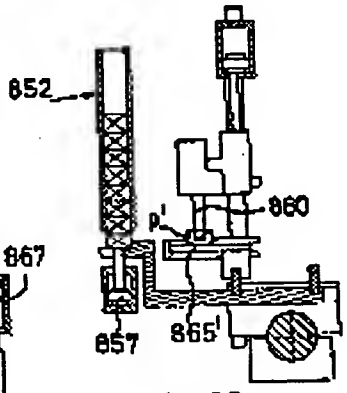


Fig. 36